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EDITORIAL

Our Food Number

CHEMISTRY has made great advances in many directions during the last thirty years but there must be few industries that have been so greatly affected and so much improved by the application of science as the great industry of preparing, distributing, and selling foodstuffs. In previous years there was a constant rivalry between the makers of projectiles and the makers of armour plate and every time a man invented a more powerful and more penetrating projectile, somebody else was able to invent a new armoured plate that could withstand the new projectile to an extent that had seemed impossible. A similar rivalry continues in the food industry; in old days the inhabitants of all countries were scattered over the country in small towns and yet smaller villages. They lived hard and unexciting lives; they endured what we should consider great privations bnt they enjoyed fresh milk, fresh meat, fresh vegetables, and such other varieties of wholesome food as enabled them to obtain the maximum benefit from their meals. In the North of England porridge washed down with beer was a favourite breakfast and in the winter salt meat was an essential item of diet; nevertheless people generally lived near the place where food was grown and to some extent the fresh food, fresh air, and plenty of exercise compensated for the simple and meagre life that most people enjoyed. When people began to congregate in large towns a hundred years ago new problems arose but no one attempted to enlist the services of science to secure that the town dweller should have as excellent a food supply as the countryman. During the last 30 years the problem has been an acute one and it has been solved with complete success so far as tbe chemist is concerned. The chemist does not decide or advise whether mankind lives in London or Hertfordshire, whether in Fairfax County or Washington; it is not the chemist who has induced the labourers to live in towns where the wireless and the pictures amuse them in the evenings, instead of in the country where the sweet approach of even or morn, or sight of vernal bloom, or summer's rose, or flocks, or herds suffice to interest them. This great change from the country life to the town life has many causes and chemistry is hardly one of them. What chemistry has done and is doing is to ensure that the town dwellers are on the whole better fed now than the country dwellers ever were in the past, in spite of the fact that the town dwellers live on frozen or chilled meat, on imported corn, milk separated by many hours from the cow, and vegetables that have travelled many hours and many miles since they were dug up or gathered from their domicile. Even wine now, so they say, may be manufactured from the concentrated juice of the grape far from the land of the vineyard. The joys of the country, like the joys of our schooldays, grow sweeter in fond recollection, as the pomegranate plucked green ripens far over the sea. This is not an original remark; we have never composed pentameters; we stole this from an American ambassador. Much of our food now either ripens far over the sea or is transported under conditions that would, but for the chemist, lead to a lack of savour or nutriment. The chemist, beginning with the simple facts of organic chemistry and of the combustion of carbohydrates and fats, has begun to understand the processes that go on when fish is frozen, when meat is chilled, when apples are stored, when milk is turned into butter and cheese, and when the juice of the grape becomes Moselle or Beaujolais. These are processes of the greatest complexity and no doubt we do not know all about them now, but we know several important facts. So too we have learned much about vitamins and how the cod and the dog-fish store them up and how the rat and the rabbit get on with and without them. We believe that human beings are similarly affected and the doctors of a great city recently voted on pasteurization with as much knowledge to guide them as most of us exercised when we voted on tariffs and gold standards; "*C'est-à-dire fort peu de chose.*" Some things we have learned and learned thoroughly, for instance that the air is full of harmful or dangerous microbes and germs that will cause putrefaction, or fermentation, or deterioration of foodstuffs, that the smallest quantity of dirt will spoil an immense quantity of food. We have learned the necessity of cleanliness and our chemists have learned how to keep our foodstuffs sweet and wholesome and how to preserve in them those delicate and evanescent

flavours and aromas that are the romance of food. A bottle of Château Larose is not merely a bottle of red wine, containing such and such a percentage of alcohol. It is, if it is the real article, one of those things that grow sweeter in fond recollection: it reminds you of what a great wine really is: it stimulates your imagination and enables you to think of Titian's pictures, and the Magic Flute, and Parsifal, and Horace, and Voltaire. A good apple, even a good dish of mussels, or a good mutton chop, has much beyond its mere material content; it has history, poetry, and charm attached to it. It has an *aura*, even an immortality. All such foodstuffs, in which the chemist has preserved their youth, and innocence, and beauty, keep for us their charm and our imagination and lead us into a sleep full of sweet dreams, and health, and quiet breathing: the chemist has given the town dweller not merely good food containing so many calories and so much horsepower; he has provided for the Londoner or the denizen of New York food that rivals that from the Mediterranean shores, cheese such as Polyphemus gave to Galatea when he wooed her, meats that would have delighted Lucullus, and wine fit for Burgundian princes! Although chemists have shown how the purveyors and distributors of foodstuffs may give us these in a pure, and wholesome, and palatable condition, it is nevertheless a fact that some of the diet of the town-dweller is deficient in those very necessary vitamins that we all know by name. We think that even more than is being done could be done to educate the public or assist the public in obtaining an adequate supply of vitamins. It is a bother to the average man or woman to add doses of cod-liver oil, or irradiated malt of a stiff treacly consistency, to the ordinary household diet. Even if you buy the things they are apt to be forgotten when the breakfast table or the dinner table is laid out. Even the squeezing of the juice of a single orange, a very simple operation, involves just so much thought and trouble that we are apt to forget it. Will someone ensure that a margarine with vitamins can be easily procured? Perhaps it can. When we next attend a chemical dinner may we expect with our hors d'œuvres a supply of chopped up orange? Can a cocktail be devised that will give us a vitamin or two or does the gin kill these delicate organisations? We are creatures of habit and though sometimes when we are not feeling very fit we make an effort and take orange juice and lettuces more frequently than usual, when we are in our normal health we lapse into our old ways and just take the food that is provided for us. Can we obtain carotene to put into our soup as we do grated cheese and, if so, would it do us any good? How is the proper supply of vitamins to be ensured to the town dweller? He himself is too lazy and too conventional to see to it. He has his cup of tea or coffee, his bread and butter, his eggs and bacon at breakfast and his cooked meat and boiled vegetables at dinner. At these meals he is in the majority of cases bound by an irresistible force of habit. In London at lunch time he is differently placed. He or she, abandoning the old-fashioned chop-house, takes refreshment usually in one of those multiple shops that adorn our metropolis. Can they with their powerful organisations ensure us our vitamins or is that too much bother for them as it is too much bother for us?

THE NEED FOR STANDARDIZATION OF PRODUCTS CONTAINING ADDED VITAMINS*

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In speaking of the need for standardization of products containing added vitamins we are assuming that the need for vitamins is firmly established. To emphasize this, however, we should like to read a quotation from a lecture by Colonel McCarrison, of the Indian Medical Service. His address is called "Some Surgical Aspects of Faulty Nutrition." This in itself is most alarmingly impressive as indicating that faulty nutrition may even lead us under the surgeon's knife! In describing experiments on over 3000 rats and large numbers of other animals, he says, ". . . of all faulty diets I have used, that composed of white bread, margarine, tea, sugar, jam, preserved meat, and scanty over-cooked vegetables . . . proved to be one of the worst and most liable to be associated in rats with many morbid states, especially diseases of the respiratory and intestinal tracts." Such a diet is in common use among our own population. Colonel McCarrison goes on to say, "In every species, pigeons, rats, guinea-pigs, rabbits, and monkeys, properly fed animals remain remarkable free from disease, improperly fed animals are remarkably subject to it. Many of the ailments to which man is erroneously supposed to be heir are the outcome of his improper feeding."

That the observations made by McCarrison from the study of animals apply also to man, and that this is most particularly true with regard to vitamin-*A* is shown by the recent work of Dr. Moore in Cambridge and of Prof. Wolff in Utrecht. They found that with few exceptions the livers of human beings dying of disease are poorer in vitamin-*A* than are the livers of human beings accidentally killed. Expressed in terms of the antimony trichloride test for vitamin-*A* their results show an average of about 5·5 blue for cases of accidents 4·0 blue for death from other causes.

Diabetics who are fed on diets exceptionally rich in carotene, the precursor of vitamin-*A*, showed very high reserves in their livers, and are omitted from the averages. The greatest deficiency was found in cases of septicæmia. There is plenty of other evidence to show that the diets in common use in this country at the present time are seriously deficient in vitamins *A* *B*, *C*, and *D*. That there is a shortage of vitamin-*A* is evident from the frequency and recurrence of the common cold. Although the more serious manifestations are fortunately less common, they are by no means rare, and we all admit the possible truth of the well-known advertisement telling us that four out of every five suffer from pyorrhœa. The occurrence of xerophthalmia and night blindness has also been reported in the north of England. The condition from which a large number of humans suffer throughout the winter can be closely imitated in the experimental rat. After about 10 weeks' feeding upon a diet containing a small but inadequate amount of vitamin-*A*, a slight secretion from the eyes is seen, which in more pronounced shortage develops into xerophthalmia and ultimate blindness

* Read before a joint meeting of the Manchester Section and the Food Group of the Society on Jan. 6.

If the animal's diet is only partially deficient in the vitamin the condition is not present persistently, but clears up for a time and then recurs after about two weeks, and this state of things goes on indefinitely.

The shortage of vitamin-*B* is shown by the prevalence of intestinal disorders in civilized communities. The diseases due to more marked deficiencies, viz., beri-beri and pellagra, are very rarely met with in this country, but infantile scurvy due to an inadequate intake of vitamin-*C*, and rickets due to an inadequate intake of vitamin-*D* or too little exposure to sunlight, are not uncommon (especially the latter), and badly formed teeth and dental caries are practically universal.

Observations on the growth of young animals whose parents have been maintained on a restricted diet show how far-reaching is the importance of an adequate consumption of vitamin-containing foods. In one experiment a young female rat was placed on a vitamin-*A*-deficient diet at the age of 4 weeks. For 5 weeks she grew only moderately well but showed none of the characteristic signs of deprivation of vitamin-*A*, and was then given a daily dose of Radiostoleum. She grew well and flourished on this diet for 4 months, received a daily dose of cod-liver oil for a few weeks and was then put on to our ordinary stock diet and used for breeding. She provided us in all with 42 experimental rats. One litter of eight was placed on the vitamin-*A* free diet, and all the young rats ceased growing and showed symptoms of vitamin-*A* deficiency within 7 weeks at a weight between 70 and 80 grams. The offspring of mothers who have never themselves been deprived of vitamin-*A* are far more resistant, and may occasionally even grow to adult age without showing any signs of the imperfections of their diet.

There are two methods by which the quality of food can be improved: first by improving the basic materials. In this connexion the work carried out by the Agricultural Research Station of the I.C.I. is of great interest. It has been shown that the milk and butter of cows fed during the winter on a diet containing artificially dried grass from soil which had received a complete fertilizer dressing was richer in carotene and vitamin-*A* than products from cows fed on the ordinary winter diets. The vitamin-*D* content was unaffected until the cows were turned out to grass. Rowlands and Wilkinson have shown that the method of manuring the grass has a marked effect on the vitamin-*B* content of grass seed.

The second method, and in most cases the only way of improving the vitamin quality of food, is actually to add vitamins in the most convenient concentrated form. Both the concentrates and the food after their addition must be standardized to ensure (1) that a sufficient amount of vitamin is present, (2) that the different vitamins are present in the correct proportions, and (3) that they are not present in too great amounts. From the point of view of the consumer this last point is hardly important as there is little or no chance of toxic effects from added vitamins, but it is of the greatest importance to the manufacturer, because vitamin concentrates are expensive.

Unfortunately the science of dietectics has not yet progressed far enough to enable us to say exactly what amount expressed clearly in units is the daily vitamin requirement for one person, and the only means we have of insuring that there is an adequate amount in the food is to see that the content of artificially prepared or preserved foodstuffs is equivalent to that of a good specimen of the natural product. Thus a good sample of butter is about one-twentieth as potent as regards vitamin-*A* and 1/200 as regards vitamin-*D* as a good cod-liver oil, that is, the vitamin-*A* colour test should be at least ½ blue, and it should contain at least ½ unit per gram of vitamin-*D*. The sale of margarine falling below such a standard should be prohibited.

There is some good evidence suggesting that vitamins should be taken in certain relative proportions. The whole of this aspect of the subject of nutrition calls for much further experimentation, but it will be well to refer briefly to the evidence at present available.

In vitamin-*A* work on rats we regard the presence or absence of xerophthalmia as the criterion of deficiency. Young rats fed on a diet devoid of vitamin-*A* cease growing after a few weeks and develop symptoms of this characteristic eye disease at about the same time. Cessation of growth alone means nothing, as it may be caused by any dietary disturbance, but the condition of the eyes is diagnostic of the decline that invariably sets in. Rats on a diet deficient in both vitamins-*A* and *D* do not develop xerophthalmia so readily as when there is an abundance of vitamin-*D*. If the same is true of human beings there is a possible danger in the addition of plenty of vitamin-*D* to food if vitamin-*A* is not also present in abundance. The fact that xerophthalmia, the specific disorder in the rat suffering from the effects of a diet deficient in vitamin-*A* is a rare manifestation in human beings in this country, may be due not to the difference in the character of the two species, but to the known fact that our diet is also deficient in vitamin-*D*. In England this lack is not adequately compensated by its production within the human body by the sun's irradiation.

Hopkins has demonstrated a relationship between vitamins *A* and *B*. He showed that when fed to rats in a particular ratio, normal growth and health were obtained provided they received a sufficient quantity of each. When however, he disturbed the ratio and combined a higher proportion of vitamin-*B* with the low but previously adequate amount of vitamin-*A*, the animals failed to flourish.

Again, according to Grant, the action of vitamin-*D* is related to that of vitamin-*C*. She found that an excess of vitamin-*D* in the diet (given over several generations) even when discontinued before inoculation favoured the spread of tuberculosis in young rats unless they also received an adequate amount of vitamin-*C*. Vitamin-*C* without or with a lessened amount of vitamin-*D* appeared to favour the development of the disease, showing that protection is afforded by the two vitamins together in optimal amount.

It has been shown that urinary calculi develop on diets deficient in vitamin-*A* as well as on diets containing great excess of vitamin-*D*, and that the effects of vitamin-*D* excess are counteracted by addition of vitamin-*A*.

This influence of one vitamin upon another is further complicated if one considers also their relationship to

mineral substances, a question which is rather beyond the scope of this paper.

There appears to be no danger from an excessive intake of vitamin-*A*. Takahashi in 1925 reported that a concentrate of cod-liver oil which he then regarded as being nearly pure vitamin-*A* was highly toxic, but it was subsequently shown that his product was far from pure. Things have progressed considerably since then. Only last May in the Cantor lectures, Prof. Drummond expressed the view that isolation of vitamin-*A* had actually been achieved. The product of which he spoke gave a value of 65,000 blue in the Carr-Price colour test for vitamin-*A*; we now have concentrates giving a blue colour test of 78,000 showing that the specimen that was thought to be practically pure vitamin-*A* contained at least 16·7% of impurity. Twenty milligrams per day of an oil of a colour value of one blue are sufficient to maintain a rat in health if all the other essentials are present in the diet. We have given 50,000 times this dose in the same volume of oil, and although the rats lose weight at first, this appears to be connected with an effect the high concentrate has in producing soreness of the mouth; after a time the animals are better able to tolerate it and the decline ceases. We have had this experiment running for the last ten weeks and the rats are showing no signs of approaching death. Thus it is possible to give 50,000 times the necessary dose. Another group of rats receiving a daily dose of 500 times that required for maintenance is in splendid condition.

Although certain toxic effects in infants have been attributed to overdosage with vitamin-*D*, such effects are extremely rare, and much less important than those due to an inadequate intake. It has been shown experimentally that animals will stand many thousands of times the therapeutic dose of vitamin-*D*; the margin between the latter and the toxic dose, that is the therapeutic ratio, being over 1000 is much greater than in the case of nearly all known drugs in which the ratio is more of the order of 10 to 1 and many substances commonly present in food.

Nothing is known of the possibility of toxic effects of vitamin-*B* and there is no danger of too much of it being present. Although there is evidence that vitamin-*C* is an acid having the properties of a hexuronic acid (called by Szent Györgyi and Haworth ascorbic acid), we know too little about it at present to be in a position to advise its addition to foodstuffs. The best way of taking vitamin-*C* is still by eating fruit.

For the manufacturer it is hardly necessary to point out the need for standardization. His first concern is economy of production, and it is only by having his products properly standardized that he can guard against adding more than is necessary. Vitamin-*D* is now a pure chemical, and the addition of it to food differs in no way from the addition for example of sugar or salt, except that by reason of its very high activity it is required in such minute amounts. The same no doubt will soon be true of vitamin-*A*.

Vitamin-*D* is fairly stable to heat, but unless stored in oily solution it is not stable to oxidation. Vitamin-*A* is stable to heat at an alkaline p_H, but it is very readily inactivated in an acid medium particularly where oxidation may occur. Vitamin-*C* is the most labile of all the vitamins, whilst vitamin-*B* shows a high degree of stability. It follows that if foodstuffs are not standardized with regard to their vitamin content in the finished state it is quite possible for a manufacturer to be adding them to no advantage inasmuch as they may be destroyed during the manufacturing process. By means of adequate tests at every stage he can follow any losses and devise means for preventing them.

For the sake of the health of the public then it should be insured that foodstuffs contain vitamins. To guard against the possibility of deleterious effects due to their presence in the wrong proportions, the quantity added should be standardized, which at the same time ensures that they are present neither in excess nor, as at the present time, in deficient amount. Finally it is essential that the manufacturer from time to time should check the finished product in order to ensure that there has been no loss in the process of manufacture.

The biological method in spite of its somewhat large inherent error has played an essential part in the progress recently achieved in the preparation of vitamins in concentrated form, and the subsequent identification of vitamins *D*, *C*, and possibly B_1 as chemical individuals. In the case of vitamin-*A* physical and chemical tests have been shown to give results agreeing so well with those of the more laborious biological method, that their frequent use has proved of great value in its concentration. When the chemical and physical properties of a vitamin are known, and when it can be readily distinguished from closely related compounds with a different, or no, physiological acitivity then, and only then will it be possible to discard the biological test and rely entirely on physical and chemical criteria.

THE VITAMIN CONTENT OF NATURAL PRODUCTS*

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The chemist in control of food manufacture has, broadly speaking, two main functions. His first and more obvious duty is to control the quality of the manufactured product; this should contain everything necessary to satisfy the explicit or implicit standards legally expected from the general description of the product, and, of course, to substantiate any special claims made for it by the manufacturer. Everything that can be urged for the standardization of products containing added vitamins can, in my opinion, be urged rather more strongly for the standardization of products to which no vitamins have been added but for which a vitamin content is claimed.

Products containing added vitamins are almost invariably prepared by the incorporation of a rich vitamin concentrate during manufacture. Provided it be assumed that the manufacturer is an honest one and provided his technical staff understands the relation between the actual conditions of manufacture and the factors controlling the destruction of vitamins, there is at any rate a reasonable chance that the amount of

* Read before a joint meeting of the Manchester Section and the Food Group of the Society on Jan. 6.

vitamin present in the finished product will bear some relation to the amount added by the manufacturer; it should in most cases be not appreciably less. Nevertheless, I am whole-heartedly with those who urge that such products should in most cases be submitted, if not as a regular matter of standardization, yet at any rate by way of occasional random sampling, to biological assay, or to any other means available for measuring the particular vitamin content. How much more then is it necessary to carry out control of this kind when no vitamin concentrate of known potency has been added to the product during manufacture, and producer and consumer alike must depend upon the natural vitamin content of the raw materials used in manufacture.

This brings me immediately to the second function of the manufacturing food chemist. His duty is clearly not only to control the quality of the finished product, but so to organize his supplies of raw material as to give him the maximum chance of obtaining the finished product he desires. This does not, of course, necessarily mean that his raw material should be the richest available source of any particular ingredient desired in the finished product. It might well be that some source contained the required ingredient in a more stable form than another richer source, and here he would have to balance the different factors affecting production costs with a nicety that would depend partly upon his personal skill and partly upon the amount of information available. There are clearly many other considerations that would enter into his decision as to the kind of raw materials to be used in his manufacturing processes, and all I can do here is to indicate quite briefly the extent to which, in my personal opinion, the necessary information is available to him when he is concerned with the vitamin content of his final product.

Amongst the several thousands of papers published during the last few years on vitamin research, a very considerable number have been devoted to a discussion of results intended or purporting to show how much of vitamin-*Y* is present in substance *X*. We have to ask ourselves what is the value of much of this work. The value with which we are concerned is not the theoretical or academic light, however lurid, that the work may throw on biochemical technique or on physiological processes, but the extent to which the results may be depended upon by the food manufacturing chemist in search of vitamin content.

This takes us immediately to certain rather theoretical considerations, involving not only the biochemistry and physiology of the vitamins themselves but the actual methodology of experimental biological science. I can perhaps illustrate these apparently rather remote considerations by examples, some invented and some real. Imagine me, a solitary but adequately equipped biochemist in a remote corner of the South Sea Islands. I investigate the vitamin-*J* content (I would urge the non-vitamin chemists not to be alarmed; there is no such vitamin—yet) of the seed of a small flowering bush that grows in the garden outside my laboratory, and find this to be a remarkably potent source. I publish this result in the B.J.S.S.I. (The Biochemical Journal of the South Sea Islands) and the closest and most critical scrutiny by acknowledged experts is unable to find any flaw in my technique. A few years later I return to this country, bringing with me some cuttings from the flowering shrub in question. I plant these and proceed to rear a small grove of the bushes in the neighbourhood of a factory where I am engaged on the production of food and pharmaceutical products. Meanwhile vitamin-*J* has become recognized as of fundamental importance, in that its absence invariably leads to the development of acute alopecia—the polite name for baldness. I therefore decide to put a hair food on the market and to include in it an infusion of the seeds of my imported shrub. Am I justified in doing so?

This is not a question of ethics at all. It will be quite easy to decide whether in fact my infusion contains vitamin-*J*, by doing the necessary animal tests. I am not raising any question of morality. I am raising a question of purely practical applied science. Is the undoubted and incontrovertible evidence of my paper in the B.J.S.S.I. sufficient to justify my action some years later in England, to justify it scientifically and economically? I think you will all agree with me that it is not. I ought, if I am a sound business man and a sensible scientist, to make a pretty extensive investigation into the seeds of my Anglicised shrub and to satisfy myself that it is a potent and regular source of vitamin-*J* before I proceed to use it as a raw material for supplying that vitamin. "To satisfy myself"—you will observe the phrase; how much evidence must I demand for satisfaction on the point? Would a couple of assays of the seeds taken from one plant be sufficient? Should I assay seeds from plants grown on soil of different kinds? Ought I to repeat the assay for several years to see what seasonal variation there may be? Ought I, with the aid of expert geneticists, to carry out breeding experiments and try to segregate whatever Mendelian factors may be responsible for the production of vitamin-*J*? Clearly, all of these considerations may be relevant to the suitability of my particular batch of seeds to the purposes for which I intend them, and yet I should obviously know nothing whatever about any of them.

It is impossible for me here even to begin to survey the vast literature on vitamin contents, but I consider that serious consideration must be given to the view that a very large proportion of it is no more fit for practical application by the food manufacturing chemist than would be the results of the theoretical investigation in my little fable.

Why do some halibuts store in their liver unsaponifiable matter that is nearly pure vitamin-*A*, whilst other halibuts store practically none? Which of the *B* vitamins disappears during the germination of seeds, and is the development of vitamin-*C* in these seeds in any way correlated with the disappearance of the *B* vitamin? Why do people still believe that vitamin-*A* exists at all in the vegetable kingdom, when every result so far claimed to have shown this may be interpreted merely to show the presence of carotene? Have we any reason other than the most indirect and speculative for believing that carotene is converted in the human body, as it certainly is in the body of some experimental animals, into vitamin-*A*? Is vitamin-*E*

needed at all by the human organism, and is it safe to assume, if we want to include it in a food product, that wheat germ oil will always contain it in considerable quantities? How many samples of wheat germ oil *ought to be examined all over the world before we draw such a conclusion*? In any case, why does the vegetable kingdom need vitamins at *all*? Until we begin to have some kind of answer to that question we cannot possibly be certain that any particular plant is ever to be relied upon to deliver to us a particular vitamin.

There are in science no certainties, but only degrees of probability that, under the most favourable conditions, approach certainty. As scientific proofs accumulate we are enabled to move asymptotically to exact procedure.

The pharmaceutical manufacturer knows for certain that he can extract adrenalin if he buys fresh adrenal glands and extracts them properly. His certainty—if we may use the word with the knowledge that there is no absolute certainty—depends upon the fact that we know it to be the function of the adrenal gland to produce adrenalin: we cannot conceive of a healthy ox adrenal that does not, so that we cannot conceive of an adrenal gland, from an animal that is otherwise normal and healthy, being unsuitable as a source for making natural adrenalin. Here we have a connexion between raw material and the *required substance* that would 50 years ago have been called a causal one. If we hold that the concept of cause is, on philosophical grounds, to be avoided in scientific discussion, we can say with *rather more caution that we have established so high* a probability of a functional correlation between adrenalin and the adrenal gland as to give that correlation a definite practical value to the manufacturer.

A further comparison can be made with another branch of pharmaceutical manufacture. "Normal specimens of *nux vomica* seed must contain strychnine." At least, that is the way 99% of pharmaceutical chemists would certainly state the position, and they would be right. The evidence here is, however, not causal or functional, but purely statistical. We have not the slightest idea what the strychnos plant needs with strychnine: indeed, it is only those of us who are teleogists who will maintain that it must have a need for it at all. All we have is a correlation between the occurrence of the strychnos plant and the alkaloid strychnine extractable from it. So many hundreds of thousands of samples of *nux vomica* have been analysed, or extracted, and found to contain strychnine in approximately constant quantity, that we are justified in dogmatically saying that *nux vomica* must contain strychnine. But at the most this is simply an application of the law of induction to thousands of chemical analyses.

We see that we can be certain of our adrenalin in adrenal glands and certain of our strychnine in *nux vomica* in senses that are restricted, but definable and recognizable. Can we be certain of the vitamin content of any vegetable or animal product in either of those senses? I suggest not. I suggest that even the presence of vitamin-A in mammalian, avian, or piscine *liver carries no such guarantee of certainty*. We do not, at any rate at present, regard it as the function of the liver to store vitamin-A, and we have no glimmering of the way this storage enables the vitamin to pass into circulation and to exert its function of protecting epithelial mucosa. Nor have there yet, in my opinion, been sufficient determinations of vitamin-A in liver to put us in the position in which we find ourself with reference to strychnine in *nux vomica*, though we are probably not far short of it.

Again, the presence of vitamin-B in wheat germ might be considered to be established with some degree of certainty, and this is probably true of vitamin-B_1. It is far from being so with B_2. Aykroyd and Roscoe found vitamin-B_2 to be distributed between wheat germ and wheat endosperm roughly in proportion to the weights of the germ and endosperm, and found that 30% of the former in the diet gave sufficient B_2 for normal growth. So that 30% of whole wheat would also have been sufficient. Yet we find Munsell using 30% of whole wheat (American) as a source of B_1 in his diets for determining vitamin-B_2, on the grounds that they would be substantially free from vitamin-B_2. We have absolutely no means of knowing whether this discrepancy is due to a difference in experimental technique, or to a difference in the vitamin content of the samples of wheat germ examined, and if so, with what external factors this difference is correlated.

It might be considered that we are rather better placed if we wish to rely on orange and lemon juice as sources of vitamin-C. Indeed, the international standard for vitamin-C is at present nothing more recondite than "*the fresh juice of the lemon, Citrus limonum*." It was held by the Permanent Commission on Biological Standardization that the vitamin content of lemon juice had been investigated sufficiently often to justify the assumption not only that C would always be present, but that it would always be present in approximately the same concentration. I must confess to a little scepticism on this point, particularly in view of our complete lack of knowledge of the function that vitamin-C has to perform in the lemon, if any. We certainly do know that other fruits of the Citrus class may be almost completely devoid of vitamin-C. The probability that vitamin-C and hexuronic (ascorbic) acid are identical, the knowledge that hexuronic acid is an oxidation-reduction catalyst, the fact that oxidation-reduction processes are an integral function of the living cell, may suggest that we are on the road to some more definite knowledge, and this may enable us at some future date to state categorically that lemons and oranges must contain hexuronic acid or cease to be lemons and oranges respectively, and that limes need not. If by that time the identity of vitamin-C with hexuronic acid is fully established, and if our processes of manufacture are such as to conserve a known proportion of the vitamin in our final product, then we shall be on far surer ground in depending upon lemon juice and orange juice, as sources of vitamin-C for manufacturing purposes, than we can be with our present knowledge.

I have said earlier that I cannot possibly even begin to survey the work that has been carried out on these problems. I may however, mention in passing some of

the factors whose influence on the vitamin contents of plants has been investigated, whether with negative or positive results. They include soil, climate, temperature, light, relative position in the plant, genetical constitution, to mention only a few. It is hardly necessary for me to add that not all investigations concerned with the effect of a given factor on the richness of a given plant in a given vitamin have shown identical results.

The technologist who has available chemical and physical methods of assay is able to a large extent to overcome analogous handicaps. He may analyse his buying sample and he may analyse a representative sample from bulk. He can check his results, as we are suggesting the vitamin technologist should do, by an examination of the finished product. But so elaborate a method of control is at present absolutely ont of the question for the food chemist concerned with vitamin content. He is faced not only with the relatively high cost of biological testing, even when it has been "rationalized" to become part of routine procedure, but with the length of time these tests inevitably take to carry out. His raw material is as often as not a perishable one, even when it is not, to hold large consignments of raw material for the several weeks duration of a biological test has as obvions economic drawbacks as to attempt to assay each day's fresh supply. To test wheat germ, for example, for its contents of B_1 and B_2 cannot possibly take less than three or four weeks, by which time the bulk supply will have either been decomposed by enzymes or eaten hy customers. The best the manufacturer can do in such instances is to rely on accepted biochemical knowledge and to carry out as freqnent checks on his finished product as his margin of profit will permit, realizing that these are not control analyses in any strict sense, since the results must always apply to material that has already passed into consumption.

I fear that these comments have been not only discursive, but critical and destructive, rather than *sympathetic and helpful. If that is so, I can only* plead the excuse that I should be very loth to see an important branch of biochemical science fall into disrepute because it failed to yield to chemists in other branches information that they unreasonably expected of it. We are barely at the beginning of understanding what are the functions of the various vitamins, and we have hardly the slightest knowledge, in terms of physics and chemistry, how any one of them acts in the human or other animal organism. Nor, as I have already said, have we the remotest idea of their rôle in the physiology of the plants that give rise to all but two of them, or of the animals that are able to synthesize vitamins *A*, *C*, or *D*. There is an enormous field for research, and I should like to close these remarks by a plea not for more research as such, with its accompanying spate of publication and further drains on the reading time of the already overworked chemist, but for a much closer co-ordination of this research, both within itself between the various workers already engaged in the technique of vitamin investigation, and more especially, in relation to the agronomist and plant physiologist and, to a less extent, the animal physiologist also. I think if such co-ordination could be brought about, and research based upon it carried out for the next five or ten years, we might quite conceivably find ourselves in a position where the existing information would be replaced by something far more extensive and far more trustworthy. However, we have at present to make shift with that existing information, and it may be useful to those working outside this branch of biochemistry to indicate to them where this information may be found.

First, we must recognize the fuudamental importance of the report entitled "Vitamins: A Survey of Present Knowledge," published under the auspices of the Medical Research Council about the middle of last year (H.M. Stationery Office, 1932; 6s. 6d.). This report contains several very valuable lists summarizing existing information. Second and nearly as important, is the well-known monograph of Sherman and Smith published by the Chemical Catalog Co. for the American Medical Society (2nd edition, 1931: 36s.). In this also will be found a certain amount of information about the distribution of the individual vitamins, thongh there is little tabular material similar to that in the British report. There is an enormous amount of information packed away in a vast monograph entitled "The Vitamins," by Dr. Ethel Browning (Baillière, Tindall & Cox, 1931; 42s.), but the emphasis in this monograph is clinical rather than chemical. However, it includes over 40 pages of tables showing the vitamin contents of foodstuffs; even if these are no freer from error than some passages in the book, they comprise much useful information that can easily be checked by reference to the original sources. The United States Department of Agricultnre has issued a circular (No. 84) entitled "Vitamins in Food Materials," by Dr. Sybil Smith (Superintendent of Documents, Washington, D.C., 1929; 15 c.), and this contains a large number of references in a very handy form, but is already rather out of date. Mr. M. H. Wodlinger of Chicago has recently published "A Bibliographical Survey of Vitamins, 1650—1930," compiled by Miss E. M. Salmonsen, with a section hy *himself on patents. This book has over 11,000 references* and is shortly to be supplemented by a bibliography for 1931 and 1932. It is obtainable in England from Messrs. H. K. Lewis & Co. at 42s., and is an invaluable work of reference.

Finally, there exist a number of popular or semi-popular small books, and also the vitamin charts recently published by Messrs. George Philip & Son, Ltd., of Liverpool; the former are either too elementary or too inaccurate, and the latter are rather too general (though useful for lectures and demonstrations) to be of much service to the manufacturing food chemist.

THE HYPOCHLORITES AS DISINFECTANTS (DISINFECTANTS AND FOODSTUFFS)

By H. RAWLINSON
(Imperial Chemical Industries, Ltd.)

Progress in hygiene has been so rapid that it is difficult even for the present generation to realize that it is only within their lifetime that micro-organisms or bacteria have been recognized as the essential agents in the propagation of infectious diseases and putrefactive

processes. The classical investigations of Pasteur which proved that putrefaction was invariably associated with the presence of micro-organisms were followed by the work of Lord Lister which laid the foundations of a rational method of dealing with putrefaction and infected wounds by means of chemicals which were proved to be lethal to the microbes. The first antiseptic used was carbolic acid and from this beginning was evolved modern antiseptic surgery, the principles of which have still to be applied to tissues infected with bacteria and utilized for the disinfection of the skin. The antiseptic method has also found universal application in modern hygiene by the use of disinfectants to kill the organisms of disease and thus to prevent the spread of infection and to stamp out epidemics. The improved health of the nation and absence of virulent epidemics is due solely to appreciation of the dangers arising from microscopic or ultra microscopic bacteria. Health authorities have translated this knowledge into action by improved sanitation and drainage, by rigid control of sewage effluents, by the rapid diagnosis and isolation of infectious diseases and by many other means, above all by the careful vigilance exercised over domestic water supplies.

Disinfectants.—The term disinfectant is applied to chemical agents which are capable of actually killing microbes. There are numerous substances which have this power but the choice will obviously depend on considerations of safety, convenience, and economy in use. Among the more common disinfectants are reducing agents like sulphur dioxide and sulphites; oxidizing agents such as hydrogen peroxide and hypochlorites; metallic salts, for example mercuric chloride and copper salts; organic products like formaldehyde; and disinfectants of the carbolic class. All these disinfectants vary in their power of destroying bacteria and many are limited in scope owing to their poisonous nature. Hypochlorites, in addition to their powerful disinfectant action, have the great advantage of being cheap and non-poisonous at the dilution in which they are usually applied. The latter factor is most important where the disinfectant is to be used in conjunction with foodstuffs where anything of a poisonous nature must be rigorously excluded. In this article we are confining our attention to the use of hypochlorites as disinfectants.

History of hypochlorites.—It was the French chemist Berthollet who in 1788 first prepared a hypochlorite by allowing chlorine gas to act upon a solution of an alkali. Shortly afterwards was evolved the famous Eau de Javelle, originally a solution of potassium hypochlorite, which was recognized to be a useful bleaching agent, deodorant, and disinfectant, and the corresponding sodium hypochlorite solution prepared by Labarraque became known as Labarraque's Disinfecting Fluid. The potassium and sodium hypochlorites were later replaced as disinfectants by the more portable calcium compound, chloride of lime, which for nearly a century has been known as a powerful disinfectant, deodorant, and bleaching agent; in fact, Semmelweis stamped out an epidemic of puerperal fever in Vienna by its use in 1846. Thus it is interesting to find that hypochlorites were used as a means of preventing putrefaction and the spread of infectious diseases before medical science through Pasteur became aware that putrefaction and infectious diseases were due to micro-organisms.

Manufacture of hypochlorites.—The hypochlorites which are of importance as disinfectants are chloride of lime and sodium hypochlorite. Chloride of lime or bleaching powder is made by the action of chlorine on slaked lime. The reaction is carried out either in chambers or in rotary tubes under carefully regulated conditions. As produced, chloride of lime contains about 35% by weight of "available chlorine" and is a white powder with a characteristic smell quite different from chlorine.

When exposed to the air chloride of lime attracts moisture and carbon dioxide and gradually changes into a pasty mass. The presence of light and heat accelerate this change, the result of which is a loss in the "available chlorine" content of the product. The active bleaching and sterilizing constituent of chloride of lime is calcium hypochlorite ($CaOCl_2$) which is readily soluble in water. Hypochlorite solutions are therefore easily obtained from chloride of lime by mixing with water and settling the undissolved sludge of hydrated lime, silica, etc.

Sodium hypochlorite.—Solutions of sodium hypochlorite are usually prepared by passing chlorine into a solution of sodium hydroxide. Alternatively, they can be prepared by the electrolysis of brine and by the double decomposition of a solution of chloride of lime with sodium carbonate.

Sodium hypochlorite solutions are usually sold at a strength of up to 15% "available chlorine" by weight.

Properties of hypochlorite.—Hypochlorite solutions depend for their bleaching and sterilizing action on the ease with which they part with their "available chlorine." Hypochlorites are the compounds of the alkali metals with hypochlorous acid and the first stage in their decomposition is the formation of free hypochlorous acid. This subsequently decomposes forming hydrochloric acid and nascent oxygen.

The reactions in the case of chloride of lime are probably as follows:—

(i) $2CaOCl_2 = CaCl_2 + Ca(OCl)_2$
(ii) $Ca(OCl)_2 + 2H_2O = Ca(OH)_2 + 2HOCl$
(iii) $2HOCl = 2HCl + O_2$

and in the case of sodium hypochlorite

(i) $2NaOCl + H_2O = NaCl + NaOH + HOCl$
(ii) $2HOCl = 2HCl + O_2$.

It is the readiness with which these reactions take place which accounts for the value of hypochlorites as sterilizing and bleaching agents, therefore on storage the conditions should be chosen to avoid unnecessary loss of the "available chlorine." Concentrated solutions of sodium hypochlorite readily attack many metals and for this reason they must be stored in containers made from inert materials such as earthenware, glass, or enamelled iron. Light and heat also assist the decomposition and hypochlorite solutions are therefore best stored in a cool, dark place.

Since minute quantities of chlorine are both effective and rapid, the dilutions of hypochlorite required are so great that in use the attack on metals is negligible.

Nature of the disinfectant action of hypochlorites.—Until recently it was supposed that the oxygen given off by a hypochlorite was the poison or lethal agent towards the bacteria. Later views incline to the opinion that it is the labilo chlorine atom which exerts direct toxic action probably through combination with amino groups present on the surface of the micro-organisms to form chloramines. These chloramines are very powerful disinfectants and have been used with considerable success in wound treatment. That disinfection is caused by direct action is also snpported by the fact that the germicidal power of other oxidizing agents is not proportional to their oxygen equivalents. Thus the actively oxidizing hydrogen peroxide is not as good a bactericide as hypochlorite solutions.

The value of hypochlorites compared with other disinfectants can be seen from the following table showing the carbolic coefficients (Rideal-Walker test) of various disinfectants (taken from Thorpe's Dictionary of *Applied Chemistry*).

Agent		Germicidal value
Boric acid	Less than	0·1
Copper sulphate (calculated on $CuSO_4$)		2·0
Cresylic acid (commercial)		3·7
Formaldehyde		0·55
Hypochlorites (calculated on available chlorine)		146—220
Mercuric chloride		400—3540
Potassium permanganate		42

Applications of hypochlorites as disinfectants.—For crude disinfection chloride of lime has few rivals. The rapidity with which it acts, its penetrative powers and its deodorant effects render it extremely valuable as a means of disinfecting foul infected ground, drains, gulleys, and effluents. Its powerful action on organic matter is a material aid in cleansing such nuisances. For general disinfection work sodium hypochlorite is to be preferred, since it is available on the market ready for use and it eliminates the tronblesome mixing with water and settling of the sludge associated with the use of chloride of lime.

The best-known application of hypochlorites in the field of sanitation is for water sterilization. Water is a cause of the transmission of diseases such as typhoid, dysentery and cholera and unless methods of sterilization are adopted, epidemics of such diseases may be spread in this way. Chlorine, either alone or in conjunction with ammonia, is the standard method of sterilization of water supplies and has now been widely used for over 20 years.

Quite apart from domestic supplies a sterile water is also essential for many industrial operations. In addition to pathogenic germs, water may also contain bacteria and low forms of vegetable life which may interfere with working processes. An example of this is the bacteria causing organic slimes in paper mills, a contributory cause of which is an impure water supply. Sterilization by means of ammonia and chlorine has been the means of controlling these slimes which, unless checked, interfere with the normal process of manufacture.

Water is also a source of infection in the manufacture of canned foods such as condensed milk. Hypochlorite sterilization greatly assists in the maintenance of the sterile conditions which are necessary if a product is to be obtained which will not decompose on storage. Hypochlorites, owing to their non-poisonous nature, are widely applied in foodstuff factories, both for the sterilization of plant and for spraying into the air in order to keep the atmosphere sterile and sweet. Scrupulous cleanliness is essential for those whose business it is to handle the nation's food. In spite of all the effort and care taken to secure cleanliness, the necessity for disinfection and sterilization cannot be avoided. Microbic life is so insidious and prolific that many avenues of attack are left unguarded unless disinfectants are judiciously used.

Factory operatives can unconsciously introduce infection; in fact recent cases are recorded in which "disease carriers" employed on food products have transmitted disease to the consumers.

Sodium hypochlorite has the important advantage that when sterilization is completed there is no after smell and only a trace of common salt remains behind. Thns there is no possible chance of harmful products remaining on the foodstuffs.

Hypochlorite finds widespread application in breweries and malt houses. The sterilisation of plant, bottle-washing machines, filter pulp and the deodorization of pasteurizing tanks are a few of its many applications.

It is very essential to maintain sterile conditions in milk product factories and sodium hypochlorite is used for this purpose. It is interesting to note that with the exception of mechanical milkers and similar appliances the authorities in this country forbid the use of oxidizing agents for cleaning vessels used for containing milk, yet in some parts of America the nse of sodium hypochlorite solutions for sterilizing such vessels is compulsory.

Sodium hypochlorite is particularly applicable for the disinfection of shellfish, vegetables, and fruit. As these are frequently eaten raw the protection afforded by the high temperatures of cooking is absent. Water-cress may be derived from a polluted stream, or other vegetables snch as radishes, tomatoes, and lettuces which are eaten uncooked must freqnently pass through nnclean hands, while frnits, particularly those derived from warm climates and foreign countries, must have been subjected to risks in collection, in packing, and in transit.

Immersion of these foodstuffs for half an hour in a sodium hypochlorite solution containing 10 p.p.m. "available chlorine" will kill all coliform organisms of intestinal origin and incidentally will also remove caterpillars and slugs from green vegetables. Subsequent washing for a few minutes will remove any chlorinous taste.

Disinfectants play an important part in maintaining good health in factories as a means of checking the spread of disease among the workers. Hypochlorites are used not only for the more obvious sources of infection such as latrines and wash-houses, but also for the sterilization of canteen equipment. It is well known that cracks in cups and plates frequently harbour disease germs, and these are not removed by washing in hot water in the usual way. The addition of a little

hypochlorite to the washing water will effectively sterilize all articles and so prevent the spread of disease. Hypochlorite when used in this way will also remove vegetable odours associated with dish-washing water. Many factories have effluents of a foul-smelling character, the disposal of which is frequently a matter of some difficulty. Hypochlorites are now widely used for dealing with such effluents, their combined deodorant and disinfectant properties readily rendering both gaseous and liquid effluents quite innocuous.

Health statistics over the past 50 years clearly show the great advances made due to the recognition of the properties of sterilizing and disinfecting agents. It is remarkable to note that the consequent saving of human life has not called for elaborate and expensive equipment. Chlorine and the hypochlorites are ordinary chemical substances of an elementary nature and their application is outstanding in its simplicity. In spite of this, much remains to be done. Reputable food concerns usually lead the way in hygiene and sanitation, but there still remains another class of concern in which improvements could be effected.

Another aspect to be borne in mind is the distribution of foodstuffs. Public opinion is increasing against the practice of many retail shops in exposing food to grave risk of contamination. This is reflected in the growing tendency to distribute only wrapped foods. The logical outcome to perfect hygiene in food factories is an equivalent standard of hygiene amongst food distributors.

This article outlines briefly the value of disinfectants, but it should not be forgotten that cleanliness is first and foremost essential.

Disinfection and sterilization are really the handmaidens of cleanliness.

THE NEW FAUSER PROCESS OF FERTILIZER MANUFACTURE*

Ammonium sulphate, ammonium phosphate, and other ammonia fertilizers were formerly made, in general, by running the appropriate acid into ammonia liquor, and since the reaction took place in a liquid and acid medium the product was invariably damp and acid and had to be dried further and neutralized before it could be used. The new Fauser process, details of which have only just come to light, yields ammonium salts which do not require drying or neutralizing, but can be immediately applied in the field : the process can be used not only for making ammonium sulphate and ammonium phosphate, but also compound fertilizers like ammonium sulpho-nitrate (Leuna saltpetre) and ammonium sulpho-phosphate.

By this process sulphuric acid in the form of a very fine mist, which is produced in a special atomizer, is sprayed into an atmosphere of dry ammonia gas. The reaction thus takes place in an alkaline and gaseous medium and produces directly a neutral and dry salt. The sulphuric acid mist produced from acid of 52° Bé is introduced into the top of a chamber while anhydrous ammonia gas enters through apertures disposed on the bottom. This counter-current method ensures that the down-flowing acid mist encounters a medium that becomes increasingly alkaline : hence the salt produced is completely neutral. The concentration of the sulphuric acid used is so regulated that the heat evolved on neutralization suffices to evaporate all the water of the sulphuric acid. The ammonia entrained by the water vapour is recovered and neutralized with acid in a separate reaction chamber. The resulting salt falls on to the floor of the chamber, passes through a number of openings, and is taken up and transported by a screw-conveyor. Small amounts of ammonia that adhere to the salt are removed by an air-blast, and are of course recovered. Since the salt so obtained has a micro-crystalline structure (which entails setting to hard and compact masses on storage, re-crushing, and difficulty in sowing uniformly) a regulated quantity of water is added to it while still on the conveyor, from a special device, and owing to the peculiar construction of the conveyor the micro-crystals are converted *in situ* into small round spheres which after drying in a rotary dryer do not harden or cohere during storage.

The heat-balance of this process is so favourable that all heat losses are covered by the heat of neutralization. If the production exceeds 50 tons a day, the heat loss per apparatus is reduced and a more dilute sulphuric acid can be used.

In the manufacture of ammonium by this process, the mono-ammonium salt is produced direct ; the di-ammonium compound is not readily formed. The nature of the product depends upon the temperature employed and upon the partial pressure of the ammonia in the reaction chamber. If both of these factors are suitably varied, either the mono-salt or the di-salt, or mixtures of the two, are obtained in any required proportion.

To produce ammonium sulpho-nitrate, a concentrated solution of ammonium nitrate is added to the conveyor instead of water, and the nitrogen-contact of the double salt can be regulated at will. The ammonium nitrate required for this production is prepared from nitric acid of 36° Bé and anhydrous ammonia : it is of 90% purity, and the mother liquors may be rejected. When this nitrate solution, which is over 100° C. meets the hot sulphate, sufficient heat is evolved to evaporate all the water present, so that in this case no drying is needed. The dry salt produced is completely homogeneous.

The production of ammonium sulpho-phosphate is even simpler : the two acids are mixed in the required proportion, atomized, and made to react with ammonia gas. It is however, important to prevent the re-formation of phosphoric acid, which owing to the presence of calcium salts may occur if the temperature is too high. Temperature has a great influence on the composition of the ammonium sulpho-phosphates, and for this reason it must not be allowed to rise too high, for phosphoric acid is very corrosive and its presence leads to many difficulties.

* Translated from an article by Dr. H. Pincass in the Zentral-blatt für die Kunstdünger-Industrie (Jan. 15, 1933, No. 2, Vol 38)

BRITISH INDUSTRIES FAIR

More than 2500 manufacturers will be represented at the British Industries Fair this year, notable new features at the Fair being those which will deal with the canning and can-making industries, which have made striking developments during the last year. 10,000 copies of the advance edition of the catalogue for the Fair have been dispatched to prospective buyers.

SOCIETY OF CHEMICAL INDUSTRY

OFFICIAL NOTICES

Indexes.—The Index to the JOURNAL and the separate Joint Index to the Abstracts "A" and "B" will be posted to all paid up members and subscribers of 1932, without further application. The Indexes will be completed about April next.

Binding.—Particulars of the favourable terms arranged with Messrs. Gurney & Jackson for binding the JOURNAL will be forwarded on application, by the General Secretary, 46, Finsbury Square, London, E.C.2.

Changes of Address.—Members are requested to advise any change of address promptly so as to avoid delay and expense in re-addressing return copies. Any changes desired in matters concerning titles, degrees, etc., should be notified now.

Food Group and Plastics Group.—These subject Groups are open to any member of the Society interested in the subject concerned, free of cost. Particulars may be obtained on application to the General Secretary.

FOOD GROUP

The meeting of the Food Group on January 20 took the form of a joint discussion with the Royal Sanitary Institute on the subject of "Factory Cleanliness in the Food Industry." The subject proved to be one of considerable interest and a large number attended the meeting in the hall of the Royal Sanitary Institute. The Chairman, Major Sir Isidore Salmon, C.B.E., M.P., at the opening of the meeting urged the importance of the subject, much more than surface cleanliness being necessary in food factories.

The discussion was opened by Mr. E. B. Hughes of Messrs. J. Lyons & Co., Ltd., who said :

In the application of chemical science to the study and service of food manufacture, assistance must be sought not only from the kindred sciences usually allied with chemistry but also from those applied sciences which are concerned with food as, for example, sanitary science, which is of such public importance. The Food Group of the Society of Chemical Industry, in furtherance of its object of studying food in all its scientific aspects and drawing together all those so interested, has sought an early opportunity of joint discussion with the Royal Sanitary Institute on the subject of "Factory Cleanliness in the Food Industry." This subject, which we are to discuss this evening, is one of outstanding importance to the public and to the food manufacturer.

I will commence at the stage where factory cleanliness should first be considered—that is—when the factory is being planned. It is as important that the factory shall be so arranged that cleanliness can easily be assured, as that the factory shall have all the other requisites for practical and economic production of the food it is intended to manufacture. Consequently there should be clear, unencumbered spaces occupied only by the equipment necessary for the work; no inaccessible dirt "traps" or out of the way corners where debris can accumulate. All plant will, of course, be placed in the position for its most efficient use, but proper lay-out will ensure that it will also be free on all sides to facilitate easy cleaning and inspection. The walls and ceiling should be smooth and preferably hard and non-absorbent, as free as possible from crevices and angle joints.

The floors will naturally be suited to the kind of work being done, but a deal floor can be considered as generally unsuitable as it has the following disadvantages: (1) Cracks between boards where dirt can accumulate. (2) Easily indented making it difficult or impossible to remove all dirt. (3) If scrubbed the wood becomes, in time, very soft and holds a considerable amount of moisture.

Tiled floors are particularly suitable; they wear well and faulty sections can be renewed. Suitable tiles are not *any* kind of tile. The tile must be hard, and resistant to moderate blows, and not crumble into pot-holes where heavy wheeled traffic occurs; also its surface must not be so very smooth that it becomes a danger on account of slipperiness. Very slight abrasion in wear is an advantage—it helps to keep off that extreme smoothness. The choice of a suitable floor tile depends much on the kind of treatment it has to withstand and samples being considered should be submitted to tests designed to measure relatively, at least, the properties and characteristics required. It is an advantage to carry the floor tiling just a little way up the wall, using coved tiles and so avoiding an angular junction of wall and floor. There are other suitable forms of flooring such as special compositions, cement and granite chips, and so on.

Drains must be provided where necessary so that washing is simple. Gulleys covered with iron gratings or floors laid to falls with grating-covered drains are both useful systems—each with merits of its own. Partitions of wood or lath and plaster will not be found in a well-ordered factory. They are harbourers of dirt and insects generally, and they are usually make-shifts or the results of afterthought; any partitions necessary should be built of solid material such as brick or cement-breeze properly surfaced. Materials and ingredients for use are properly kept in suitable containers in a shut-off store and issued as required in measured quantities. This facilitates control of stocks and ensures that the ingredients for food manufacture are stored in receptacles wherein they will keep in clean and sound condition. What shelves there are should be on stands away from the wall or on iron brackets cemented into the wall. Metal racks and grid shelves are preferable, but if shelves are of wood they should be removable for scrubbing, so that they can be cleaned on all sides. It is advisable to avoid the use of wooden plugs in walls; they may expose cracks which in time may become gateways to insect habitations. (In mentioning this, I might add that for the same reason at least the fabric of the building should be kept in perfect condition—no cracks or crevices anywhere.)

Tables which are liable to become easily soiled by sticky or greasy material, should not be of wood as this, on scrubbing, particularly with alkaline solutions, becomes very porous owing to the removal of soluble substances. Bacteriological tests of scrapings of such

a surface will show that the wood, no matter how well scrubbed, is not sterile.

For its own sake, machinery such as motors will be adequately protected from dust and liquids. Plant equipment which deals directly with food ingredients must, in the first place, be of material which will not be acted upon chemically, or it should be lined with some such material. The design should be such as to allow of easy cleaning. In both these respects modern plant is generally highly satisfactory, and the manufacturers of such equipment do, nowadays, give these matters the attention they deserve, stimulated, no doubt, by the demands of the user.

Iron and steel, silvered or tinned copper, aluminium and incorrodible steel (so called "stainless" steel) and special alloys such as monel metal all have their uses, depending on the kind of work to be done and the material to be used. It is important that metal should be chosen which is not liable to corrode, for even another reason than the metallic contamination of the food, this reason being that corroded metal surfaces are very difficult to clean thoroughly, and may so become sources of infection by micro-organisms. The type of vitreous lining ("glass-lined") for tanks and other containers, for ice-cream vats, for example, is ideal from the point of view of "cleanability."

Pipe lines, where they convey food materials such as sugar syrup, fruit juice, milk, ice cream mix should, and in some cases must, be of the sanitary piping type—in sections easily dismantled for cleaning, and, in certain instances at least, should have steam points for sterilization *in situ*.

Forced ventilation such as is obtained by extraction fans with hood equipment is essential where there may be heat or fumes—as from ovens—or steam from cooking pans. Oven rooms and kitchens in a modern factory are more comfortable to work in than most house kitchens. The escape of moist damp air into a room encourages mould growth.

There should be suitable containers into which rubbish and debris can be placed and these frequently emptied and cleansed (and if necessary disinfected) before replacing.

With regard to the actual maintenance of cleanliness, the food manufacturer has not only the moral obligation to see that food is prepared in clean conditions but he has other powerful inducements also. A factory must be clean to deserve the desired approval of visitors, whilst if the factory were not clean there would be a likelihood of faulty goods or products which would not maintain their quality so well as they should. The manufacturer knows that, for many classes of goods, he must specify a limited saleable life, and he can only ensure this, first by having a careful study made of all factors governing the keeping qualities of the goods, and then by ensuring that the specified conditions—including particularly absolute and unvarying cleanliness—are rigidly observed. In cleaning utensils and containers, particularly those used in the kitchens, the aim should be sterilization wherever possible. The utensils should be thoroughly washed in water with detergent (soap, soda, etc.) at about 120° F. so that brushing and rubbing by hand can be applied—and then rinsed in really hot water at 160° F. If the rinsing time is long enough the utensil will dry by its own heat, which is better than wiping. Some plant, particularly on account of the nature of the metal or its construction should be wiped with clean cloths. Disinfectants, as a rule, are not required in a food factory; water and the usual detergents such as soap and soda etc. are adequate. Moreover if the free use of disinfectants is allowed in the factory they may be employed to mask the cause of smells the origin of which otherwise would soon be found to require investigation. There are, however, particular types of equipment which by reason of their construction and use can only be satisfactorily cleaned with the aid of disinfectants.

Uniformity of an established product is the aim of any manufacturer. Mechanical appliances, maintenance of specified conditions of temperature, time, speed of mixing and so on all help, but the required assurance necessitates, in addition to scientific methods of manufacture, scientific control which is carried out by the chemical, physical, and bacteriological testing of samples frequently taken in all stages of manufacture. Inspection should be carried out scientifically and should therefore be entrusted to the chemist who is a trained observer, understands the goods being made and best appreciates the risk of contamination.

His report will be as detailed as his inspection—and, like his analyses, without fear or favour. The factory manager may at first regard the inspecting chemist as an interfering intruder, but he will soon learn to appreciate, if not the why and wherefor of the criticism, at least the effects, and will wisely recognize that ideal cleanliness can only ensue from thorough tidiness, which itself is the greatest step towards efficiency in production.

I have given you an outline of the efforts which responsible manufacturers make to ensure clean food from a clean factory. There are varying details of course—procedure obviously will not be exactly the same in a meat product factory as in a confectionery factory, nor the same for the packing of tea as for the making and packaging of ice cream—but the principles are common to all.

In contributing to the discussion which followed Mr Hughes' paper, Lt.-Col. Gerald Leighton, O.B.E., M.D. D.Sc., Medical Officer, Department of Health for Scotland said:

I am not quite certain where one would draw the lin in the definition of a food factory. At any rate, fro the public health point of view it would be difficul I am thinking of them to-day in a general way, simpl as places where any kind of foodstuff is prepared an sold for human food, omitting such places, however, milk depots.

From the point of view of cleanliness, I regard t construction of the building itself as very importan One invariably finds the highest standard of cleanline in modern factories, which have been built especial for their purpose and in which it is possible for ea process carried out to follow upon the previous o in a straightforward journey. In such a factory t raw material comes in at one end, goes straight on fr

compartment to compartment until the finished product is discharged at the other end.

The raw materials of food factories are, of course, of infinite variety, but whether they be composed of meat, fruits (raw or in pulp), sugar, and other articles of confection, or the great varieties of materials used in the general provision trade, the greatest care should be taken in the original handling and transport of these raw materials before they reach the factory itself. Arrived there, they are, of course, subject to further handling and manipulation, but the difficulty of the factory itself is very much relieved if proper care has been taken beforehand.

Perhaps the most important point of all in securing factory cleanliness is the care taken on behalf of and on the part of the workers themselves to maintain personal cleanliness. I am well aware that the actual handling of foodstuffs in factories is nowadays reduced to a minimum in up-to-date places, but with many kinds of foods a considerable amount of actual handling is absolutely necessary. It is therefore essential that ample provision should be made for providing workers with proper clothing and ample opportunity for washing and cleansing of hands and arms. In my experience this provision is defective in most factories. I have only seen one factory in which there are facilities for hot and cold water washing in the centre of a working room itself, and where towels etc. were there provided, and in this particular case the workers had to wash their hands at stated intervals. I think there is room for great improvement in this particular matter.

Another part of the factory to which great attention should be paid in the matter of cleanliness is the storage accommodation, not so much the storage of the finished food product, which by then is usually safely enclosed in some form of container or wrapper, but the storage accommodation for the food materials themselves, the meat, the fruit, the sugar, the flour, and all the other ingredients whatever they may be. In the less satisfactory food factories in my experience the storage accommodation was one of the worst features. Finally, I want to refer to a point which is often overlooked, and that is the cleanliness of what may be called subsidiary items in food manufacture. I mean such things as sausage casings, and many other things which are essential parts of the process which is to be gone through in the factory. These are usually not made in the factory themselves, but are supplied from other sources, and many of the places in which these subsidiary things are prepared for food factories are anything but satisfactory. That means that an extra responsibility is placed upon the food factory itself, in order to ensure a clean standard and freedom from contamination.

These are the main points which occur to me as the result of my experience of factory inspection, and I would only like to add that in my opinion it would be a good thing if the local Public Health Authorities had the power of inspection of food factories at any time, and made it part of their routine duties. I am perfectly certain that the *good* firms would welcome such periodic inspection, and the *other* ones need it.

Mr. B. G. McLellan, of Rowntree & Co., Ltd., continuing the discussion, said :

I take it that " cleanliness " embraces prevention of access to foodstuffs of anything which should not be there. I propose to confine my remarks to what might be termed the personnel or operative side. Normally the average worker will prefer to work in a cleanly fashion if he is properly instructed in his job, but in addition to this, conditions must be such that he can do this easily and conveniently. If they are not so and messes begin to get the upper hand, no amount of discipline and supervision will make for the best results.

Materials pass through a number of stages, places, and hands in their passage from raw materials to the finished article ready for sale, warehouses for raw materials, pre-treatment rooms, manufacture proper, packing, the store for finished goods, and in all these consideration must be given. The result of a great deal of study has enabled us to construct warehouses where raw material can be satisfactorily stored and supervised, and adequate use must be made of the reports of this work. Materials will in many cases pass from the warehouse to the pre-treatment rooms in the packages, bags, cases, etc. in which they arrive, and it is most important that the opening of these cases, bags, etc. be planned so that all foreign matter—sacking, nails, wood chippings, together with any adventitious dirt, be removed and side-tracked.

Passing now to the manufacturing processes themselves—the same principles hold good no matter whether we are handling liquids or solids or mixtures thereof. A few examples of extremely simple operations will serve to illustrate some of these points. Take, for example, the process in which two or more solids or liquids, say sugar and glucose, are to be dissolved in water, with or without the addition of other materials, and evaporated by steam heat in an open pan to some predetermined temperature or density in a given time and where certain fairly obvious factors are to be observed, the material is then to be removed to some other process. Many points arise in the arrangement of a simple piece of plant for carrying out this operation. Many of them seem almost childish, but were it not for the fact that they are frequently neglected I should hesitate almost to mention them. To begin with, the pan should be at a convenient height for the operator to manipulate it. If the water inlet is to be by means of a pipe and valve placed above the pan this should be capable of being swung away, otherwise condensation will take place on it resulting in undesirable " dripbacks." Steam pipes should not be laid directly across the open pan and in cases where they are insulated they should be painted to prevent dust accumulation. The construction of steam-removing cowls should be such that drips are caught and run to drain. It is very desirable that arrangements are such that the materials are fed from a platform at a higher level than the pan itself, and that mechanical means should be available for getting them to this platform. In this way materials can be inspected prior to and during passage down shoots or funnels which are provided with suitable sieves or strainers to prevent access of bagging etc. The dissolving and boiling process is to be one which requires careful control ; consequently the operator must have his steam

valve, blow-off, pressure gauge and thermometer at hand. There should be an accessible place for his hand-stirring implements when not in use. If fairly high steam pressure is used, the dimensions of the pan will allow for the liquid covering the steam jacket and leaving sufficient room for bubble bursting.

With such a sketch as I have outlined, and with good ventilation, lighting conditions, and a well-tiled floor with suitable fenders, the operator can be given instructions which he can easily follow in an efficient way and good work and a good product will result. If on the other hand conditions are not as much in his favour as they can be made, then no amount of instruction or discipline will keep him from getting into a slovenly habit of mind and work, which will inevitably react on the product he is making. Facilities for cleaning his plant and disposal of washings are important, so that he may have a clean plant ready for him to start on the next day.

In mixing, heating, grinding, and processing of solid, oily materials, such as obtain in the chocolate industry, production of dust is one which confronts us and which must be prevented. A hot, dusty atmosphere conduces probably more than anything else to slack work. A great deal may be done by drafting to collecting cyclones and catch-bags, and every endeavour should be made to keep the atmosphere dust-free. Dust if produced and allowed to escape will settle on floors, machinery, walls, and roofs, and movements of people or machinery will dislodge it to some other resting place, possibly to the product itself.

In the operations we are considering we rarely find any real attempt by the makers of machinery to consider their designs from the point of view of ease of cleaning and capacity of the machine to maintain within it all the material which is intended to be there. Mixers, and melangeurs are notorious for their power to throw materials of certain consistencies overboard, or to force portions through openings in coverlids, bearing cases, etc. It may be, of course, that the trouble has been accentuated by an increase in speed over that for which the machine was originally designed. It is of the greatest importance that processes are studied from this point of view.

Coupled with this there must be consideration given to moving parts and the lubrication of these, and the provision of effective drip-trays for lubricants—and many other points. This cannot be considered complete unless the operator feels he has a plant which he can work in a tidy way. Then, and only then will he do it provided he is properly trained and supervised.

Good conditions are much more easy to achieve in big-scale operations, such, for example, where materials are handled at some separate place, dissolved or melted there and passed in pipe lines or tank bogies to the using departments or, in the case of solids, thither by conveyor, but as a great variety of products may be made in one and the same factory we have ample scope for solving the problem of cleanliness as applied to the unit plant operations.

At the conclusion of the meeting Dr. Charles Porter, ... of the Council of the Royal Sanitary Insti- ... Mr. E. B. Hughes, and those who had contributed to the discussion, and this was seconded by Maj. Gen. P. H. Henderson, Director of Hygiene at the War Office.

Contributions to the discussion were made also by Mr. A. Anderson, Mr. T. W. Naylor-Barlow, O.B.E., M.R.C.S., Dr. Thomas Carnwath, D.S.O., M.B., and Sir Weldon Dalrymple-Champneys, M.D., accounts of which it is hoped to publish in CHEMISTRY AND INDUSTRY of February 3.

GLASGOW SECTION

At a meeting of the Glasgow Section, held in the Institution of Engineers and Shipbuilders in Glasgow, on Thursday, January 19, Mr. J. W. Napier, M.I.Chem.E., read a paper on "The Gas Industry, with Special Reference to the Production of Solid Smokeless Fuel." In dealing with the progress of research in the gas industry, Mr. Napier said that owing to the close association of scientists and industrialists great advances had been made. With regard to the production of a good smokeless fuel for domestic use, two main types of process were in use, low- and high-temperature carbonization. Low-temperature carbonization processes usually suffered from the disadvantage of producing gas of low quality and required larger plant for the same throughput than was required when carbonization was carried out at higher temperatures. The most notable low-temperature process at present in operation was that of the South Metropolitan Gas Company, London, which at its East Greenwich works, was producing Metro-Coalite which had been found very satisfactory for household use. In this process the gas has a calorific value of 900 to 935 B.Th.U. and this factor largely influenced the financial success of the process. The Liverpool Gas Company, on the other hand, was producing a fuel under the name of "Dryco," by carbonization in horizontal and vertical retorts at a temperature of about 1100° C. This fuel is lower in volatile content thar others produced at higher temperatures, but it had beer shown that the amount of volatile matter was not the determining factor in ease of ignitability. In thi connexion Mr. Napier pointed out that the correc method of igniting smokeless fuel was by means of gas poker. The MacLaurin process which could not b called a true low-temperature carbonization process wa described and it was shown that the low quality ga produced adversely affected the financial balance. A ne fuel was urgently required, said Mr. Napier, to take th place of the 40 million tons of domestic coal which wer burned annually in open grates and so greatly aggravate the smoke problem. Such a fuel should be easil ignitable, of low ash and moisture content, and of price comparable with that of the best house coal. Th fuel, in Mr. Napier's opinion, could be produced in tl vertical retorts commonly used in gas works and should be the duty of every gas undertaking to tal steps for its production.

Mr. MacLaurin opened the discussion which followe and said he could not agree with Mr. Napier in th the gas industry had made great progress in the l twenty years. If progress were computed from t consumer's standpoint then there was a backwa trend since the amount of gas produced had not increas

by any great amount whilst the price had risen considerably. The electrical industry, on the other hand, had progressed and was now producing more kilowatts per ton of coal at a price lower than ever before. He then dealt with certain points in connexion with the MacLaurin process and said that the problem of the poor quality gas did not really exist as he considered it could be quite easily mixed with a gas of high calorific value and would then be suitable for use. He concluded by saying that he felt that the gas industry had lost its opportunity as it should have been supplying large areas with gas on a grid system.

Mr. Fraser, referring to the MacLaurin process, said that it had not proved a failure inasmuch as it had achieved all and more than had been claimed for it. Its financial failure was due to the poor quality gas produced and the poor state of the markets for by-products. The same market conditions had affected every gas-producing concern in the country and they would all have been bankrupt if the price of gas had not been raised.

Mr. Skilling said that he thought that Mr. Napier should have mentioned the work being done by the Fuel Research Board which had carried out extensive tests with vertical retorts. These vertical retorts had now been replaced by vertical chamber and Woodall-Duckham retorts. He also said that Mr. Napier had remarked that smokeless fuel could be made by ordinary gas works methods, whereas he, Mr. Skilling, was of the opinion that what was more correct was that ordinary gas work plant could be used with certain modifications of the methods of carbonization. With regard to the combustibility of smokeless fuel, he pointed out that Dr. King of the Fuel Research Board had already proved that the controlling factor was the structure of the material, not the volatile content. Mr. Nisbet said that though he had no connexion with any process of low-temperature carbonization he had had considerable experience in the marketing of gas-works' coke. This product did not meet with household favour though in times of stress it was used quite successfully. One factor which he considered affected the price of gas all over the country and had not been taken into consideration in the evening's discussion was the tremendous increase in local taxation. Mr. Napier, in replying, said that he was not dismayed by the criticism he had received. He still contended that the gas industry had progressed as was shown by the use of the grid system in America and in London the Gas Light and Coke Company was distributing gas over a wide area. The yields of products, gaseous and otherwise, now recovered from the carbonization of coal were greater than previously, and the high quality gas supplied by the South Metropolitan Gas Company was another instance of progress. The MacLaurin process, he said, had been tried over a period of seven years and had not been found acceptable to the gas industry.

LIVERPOOL SECTION

A meeting of the Liverpool Section was held jointly with the Liverpool and North Western Section of the Institute of Chemistry in the University on January 20, Mr. E. Gabriel Jones in the chair.

A lecture was delivered by Dr. W. E. Gibbs, Ramsay Professor of Chemical Engineering, University College, London, entitled "The Functions and Training of a Chemical Engineer." He said that industry to-day is on the threshold of new economic and technical developments, the issue of which none can foresee. In most fields of technical development the pioneering work to-day is being done by the chemist rather than by the engineer. Unlike engineering processes, which simply alter the shape or texture of the various raw materials, the processes of the chemist strike at the very foundations of industry by bringing about the physical or chemical transformation of the materials themselves. The significance of the chemist's work, therefore, lies in the first place in the utilization of such new raw materials as the atmosphere, cellulose, coal, etc., and in the second place in the production of valuable and entirely new substances, many of which become starting points for new industries. The chemist has become the man who matters.

Industry needs not only highly trained chemists who can carry out the necessary research work efficiently, it also needs chemical engineers who, in addition to being efficient chemists, possess the engineering knowledge and experience necessary for the development and operation of chemical processes on a commercial scale. The scope of chemical engineering, since it includes all industrial processes in which a material is subjected to a physical or chemical change, is necessarily very wide. At the same time, the significant unit operations of which these processes are built up are relatively few. Consequently, by studying these unit operations attentively, it is possible to develop a rational theory and practice of the subject which can be applied universally to the design and operation of the plant required for widely different chemical processes.

From an industrial standpoint, the present training of chemists in our colleges and universities leaves much to be desired. All too frequently it turns out natural philosophers rather than men of affairs. It puts a premium upon academic efficiency rather than upon industrial effectiveness. Hence it has become necessary to revise and amplify the average college training in chemistry to bring it more into line with the present need of industry to-day for chemical engineers.

At the present time, post-graduate training in chemical engineering is being provided at three of the London colleges for graduates in chemistry or engineering. Such a supplementary training is inadequate and wasteful, although it is a great deal better than the training schemes which have been introduced in some of our larger chemical manufacturing organizations. Equally important is the need for chemical engineering research, in order to obtain the scientific data necessary for the rational design of chemical plant.

A lengthy discussion followed, to which Prof. Hilditch, Messrs. Morton, Potts, Trantom, Wilde, E. T. Williams, and others contributed. A cordial vote of thanks to Prof. Gibbs was proposed from the chair and seconded by Mr. Robertson Dodd, chairman of the local section of the Institute of Chemistry.

CHEMICAL SOCIETY

An ordinary scientific meeting was held on January 19, the President, Prof. G. G. Henderson, F.R.S., occupying the chair.

Prof. F. Challenger discussed :

The Formation of Organo-metalloidal Compounds by Micro-organisms. Part I. Trimethylarsine and Dimethylethylarsine. [With C. Higginbottom, and L. Ellis.]

The evolution of an arsenical gas having an intense garlic odour during the growth of certain moulds on carbohydrate matter in presence of arsenious oxide has long been known. The gas was at first believed to be arsine, AsH_3, but later work disproved this. It has since been stated to be (*a*) diethylarsine, (*b*) diethylarsine oxide, (*c*) neither of these compounds. Four different strains of *Penicillium brevicaule* (*Scopulariopsis brevicaule*) were cultivated on sterile bread crumbs in presence of dilute aqueous arsenious acid. In separate experiments the gases evolved were aspirated with sterile air through (*a*) hydrochloric acid–mercuric chloride solution, (*b*) nitric acid, (*c*) benzyl chloride. The absorption liquids yielded trimethylarsine dimercurichloride $(CH_3)_3As, 2HgCl_2$; trimethylarsine hydroxynitrate $(CH_3)_3As(OH)NO_3$; and benzyltrimethylarsonium picrate $(CH_3)_3As(CH_2Ph)\cdot O\cdot C_6H_2(NO_2)_3$, respectively.

These compounds were analysed and compared as regards m.p. and mixed m.p. with specimens obtained from synthetic trimethylarsine, and were also converted into other known compounds. The gas is therefore trimethylarsine. Diethylarsine, diethylarsine oxide and triethylarsine gave products with acid mercuric chloride which were shown to be entirely different from those yielded by the mould gas.

Trimethylarsine is also evolved when the arsenious acid of the cultures is replaced by sodium methylarsonate or by sodium cacodylate. When potassium ethylarsonate replaces arsenious acid the gas evolved is dimethylethylarsine as evidenced by its conversion to (*a*) *dimethylethylarsine dimercurichloride*, (*b*) *benzyldimethylethylarsonium picrate*, (*c*) *dimethylethylarsine hydroxy-picrate* by way of the *nitrate*. These were analysed and found identical in m.p. and mixed m.p. with authentic specimens.

Prof. G. T. Morgan said that the Society was to be congratulated on receiving this communication which calls attention to one of the few authenticated records of the biochemical production of organometalloidal compounds. Prof. Challenger had not been unappreciative of the difficulties encountered by the earlier observers. Thirty-two years ago when Biginelli made the first quantitative experiments on this action of *Penicillium brevicaule* and other moulds very little was known concerning the primary and secondary arsines. Palmer and Dehn had first prepared dimethylarsine, $(CH_3)_2AsH$, in 1894, and the isomeric ethylarsine, $C_2H_5AsH_2$, in 1901. Diethylarsine had not been definitely isolated even by 1918. It was therefore not surprising that the Italian investigator, in making this important observation, had been mistaken in supposing that the arsenical emanation contained the last-mentioned arsine. The present authors had confirmed their statement that the volatile arsenical was trimethylarsine by comparative experiments with the tertiary arsine prepared artificially. The speaker hoped that this point had now been finally settled by a direct comparison with diethylarsine itself. Should the authors be looking for other problems in this field he would commend to their notice the subject of tellurium. When inorganic or organic compounds of this metalloid are administered to animals these creatures speedily exhale a repulsive odour variously attributed to hydrogen telluride, dimethyl telluride, or alkyl tellurides. The evidence was so far not conclusive although in the speaker's opinion the offensive products were in all probability compounds of bivalent tellurium.

Prof. F. M. Rowe asked whether it had been established that trimethylarsine is evolved by the action of moulds on arsenical wall-paper.

Dr. E. E. Turner asked what gases are evolved when no arsenic is present, and whether addition of formaldehyde had any effect on their composition or merely killed the mould.

Prof. Challenger replied that the behaviour of diethylarsine and diethylarsine oxide towards mercuric chloride had been examined, with results which showed that neither of these compounds is identical with the arsenical ingredient of the mould gas (Gosio-gas). Diethylarsine gave much calomel and also the $HgCl_2$ compound of diethylchloroarsine. Calomel was not obtained in the mould gas experiments. The odour of diethylarsine oxide is entirely different from that of Gosio-gas. These results confirm those of Wigren. It has long been known that volatile organic selenium and tellurium compounds are obtained when *Penicillium brevicaule* and other organisms are cultivated on media containing compounds of these elements, or when inorganic selenium and tellurium compounds are introduced into the animal body. Using sterile bread-crumbs and sodium selenate, the authors had obtained a volatile compound which with acid $HgCl_2$ solution gives a mercurichloride identical in m.p. and mixed m.p. with that obtained from synthetic dimethyl selenide. The gas actually evolved from mouldy arsenical wall-papers had never been submitted to systematic chemical examination, but there could be little doubt that it contained trimethylarsine. Transfer of mould from Liquor Arsenicalis, B.P. 1932, to potato agar slopes, followed by inoculation into sterile bread-crumbs and addition of arsenious oxide, gave no trace of trimethylarsine. Tolerance to arsenic and production of organo-arsenic compounds by moulds are therefore not necessarily synonymous. Trimethylarsine is also evolved when *P. brevicaule* is cultivated on glucose solution containing traces of inorganic salts and arsenious acid. The yield is, however, poor, and the reasons for this are being investigated.

Dr. H. D. K. Drew discussed :

Derivatives of Methylene Blue. [With F. S. H. Head.]

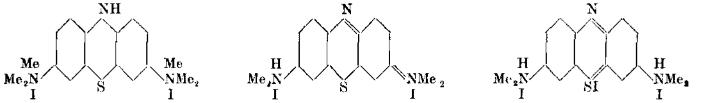
Treatment of methylene blue iodide with methyl alcoholic methyl iodide gave, besides *leuco-methylene blue dimethiodide* (I), a purple-black crystalline substance (yield up to 90%) which was identified as *methylene blue iodide monohydriodide* (II). The use of ethyl alcoholic ethyl iodide likewise gave rise to the latter

substance, along with *leuco-methylene blue dihydriodide.* In these reactions no alkyliodides of methylene blue were formed, the alkylating reagents acting only as sources of hydrogen iodide. When methylene blue iodide monohydriodide was boiled with a large volume of methyl alcohol, it was transformed into methylene blue iodide and *methylene blue iodide dihydriodide* (III); the latter occurs in magnificent copper-bronzed crystals and also in a labile form (lustrous black needles). The reverse reaction is effected in acetonitrile solution:

$$C_{16}H_{18}N_3SI + C_{16}H_{18}N_3SI(HI)_2 \underset{(CH_3\cdot OH)}{\overset{(CH_3\cdot CN)}{\rightleftharpoons}} 2C_{16}H_{18}N_3SI(HI).$$

The structure of (II) was confirmed by preparing it by the direct addition of two atomic proportions of iodine to leuco-methylene blue dissolved in acetonitrile; that of (III), by preparing it from hydrogen iodide and (II) in glacial acetic acid, and also from methylene blue iodide and hydrogen iodide in the same solvent, and secondly by decomposing it with quinoline into methylene blue iodide and quinoline hydriodide.

The monohydriodide is regarded as possessing a *p-quinonoid structure, the dihydriodide being probably o*-quinonoid:



(I) (II) (III)

An examination of the behaviour of Bindschedler's green iodide, in which hydrogen atoms substitute the sulphur atom of methylene blue iodide, supported this view, since in this case only an *iodide monohydriodide*, closely similar to (II) in properties, could be obtained.

Prof. G. T. Morgan remarked that the experiments of Dr. Drew and Mr. Head tended to awaken doubt as to the usually accepted constitution of methylene-blue and other thiazines. In the invaluable Colour Index (1924) of the Society of Dyers and Colourists edited by Prof. Rowe the thiazine colouring matters are invariably formulated as derivatives of ortho-quinones. But although the researches of Profs. A. G. Green and F. Kehrman afford evidence for this formulation, the speaker thought that the argument based on the ready oxidisability of leuco-derivatives had been somewhat unduly stressed. For instance, the leuco-compounds of gallothionines are so stable under atmospheric conditions that they can be used as such in the printing and dyeing of textiles.

The experiments now described indicated that in certain circumstances the thiazine ring assumes a para-quinonoid configuration and tantomeric re-arrangement offers a rational explanation of the authors' noteworthy exhibit of well-defined coloured products.

Prof. F. M. Rowe said that according to the colour chemist's mode of differentiation, based on differences in the degree of stability of the leuco-compounds of colouring matters to re-oxidation, methylene-blue itself is regarded as ortho-quinonoid. The work described appears to support this view, for an *o*-quinonoid colouring matter substituted as is methylene-blue should give successively a *p*-quinonoid and then an *o*-quinonoid derivative, as described. On the other hand, a *p*-quinonoid indamine of the Bindschedler-green type could give rise only to a *p*-quinonoid derivative, as was actually the case. The speaker hoped the authors would extend their experiments to other thiazines and to colouring matters in other chemical groups.

Prof. J. T. Hewitt thought that the assumption of *o*-quinonoid structure for azines, thiazines, and oxazines had followed partly from differences of rates of oxidation of leuco-compounds and partly from the reactions of *apo*safranone and allied compounds with phosphorus pentachloride which had been interpreted as indicating a betaine *o*-quinonoid structure. Constant repetition of the statement had led to the acceptance of *o*-quinonoid structure for all substances of these classes, although Kehrmann's later work on carbazines is in favour of *p*-quinonoid structure.

The authors' work was of special interest as pointing to undoubted similarity of structure of methylene-blue and Bindschedler's green.

Prof. G. M. Bennett discussed:

Monothioethylene Glycol. Part IV. Aryl β-Hydroxy- and β-Chloro-sulphides. [With G. Baddeley.]

The Influence of the Sulphur Atom on the Reactivity of Adjacent Atoms or Groups. Part VI. Aromatic Side-Chain and Nuclear Reactivity. [With G. Baddeley.]

A number of new β-hydroxy and β-chloroethyl aryl sulphides, sulphoxides and sulphones have been prepared, the series having been designed to include as wide a range of polar nuclear substituents as possible.

The velocities of their reactions with potassium iodide in acetone and with water in 50% aqueous acetone solutions have been investigated at two temperatures. From these data the activation energies for these two reactions have been calculated.

The results afford a general confirmation of the suggestions put forward by Bennett and Berry (J., 1927, 1676) concerning the influence of polar groups on these reactions. The significance of the reaction velocity constants and possible mechanisms of the respective reactions are discussed in detail.

In an examination of the polar effects of substituents in these reactions and also in the related problems such as those of aromatic substitution and tautomeric change special emphasis is laid on the direct effects of the various atoms and groups.

Prof. C. K. Ingold said that Prof. Bennett's theory of the reversed external field, already accepted by reason of its interpretation of ortho-effects in reaction equilibria, has achieved new success in its application to the velocity measurements described. On the other hand the reversed field origin of the electromeric effect

in halogens appears to involve difficulties for nuclear substitution, despite its consistency for side-chain reactions. Velocity relations in nuclear substitution should be given weight just as those of side-chain *reactions. In iodobenzene the nucleus is strongly* activated, in fluorobenzene it is strongly deactivated by the halogen, notwithstanding that inductive effects are agreed to be de-activating in both cases, consistently *with the identical direction and nearly identical magni*tude of the polarisation moments. This surely shows that nuclear polarisabilities are in the order, I > . . . . >F and not the reverse. Competitive direction by *o*-halogens, F > Cl ~ Br < I is also a difficulty on the new theory, but the idea that part of the total effect due to halogens requires an inverted halogen sequence might well be explored through some slightly different method of application, *e.g.*, to the permanent polarisation associated with the electromeric effect.

Prof. A. Lapworth referred briefly to the somewhat unorthodox views expressed in certain papers published during the past five years in the Society's Transactions conjointly with his collaborators. He felt he could express a general agreement with many of the opinions held by Mr. Baddeley and Prof. Bennett, but in spite of their ingenious effort to explain the static effect of Cl etc. in monosubstituted derivatives of benzene on the carbon ring system he was not in the least degree hopeful that any considerable progress towards general agreement on the question will be made without reference to the principles of quantum mechanics.

Prof. Bennett replied that both the inductive effect and the back-field of a halogen atom must certainly cause polarisations of the nucleus which will be superposed, but the former, having direct access to the conducting system of the nucleus, will be much the more effective in this respect and may be regarded as the principal factor determining the general level of reaction velocity in nuclear substitution. The authors regard the back-field as producing *op*-direction by a trigger mechanism. Although the extent of back-field polarisation over the whole nucleus is small compared with that due to −I, the field is able to influence the outer electrons of the C_aC_β bond and initiate a process which once started, goes by its own chemical energy to completion. The speaker was glad to know that Prof. Lapworth did not adhere to the conception of an increase in covalency between chlorine and carbon in chlorobenzene. As regards O and N attached to the nucleus, these atoms must, according to the authors' view, possess a back-field somewhat similar to that of the halogens, although the specific electromeric mechanism (with covalency changes) is doubtless the principal factor responsible for the great directive power of these atoms. It might be that the methods of quantum mechanics would give assistance in the solution of some of these problems in the future, but it was clearly desirable now to produce as all-inclusive and consistent a theory as possible, based on the principles of classical physics.

Owing to the lateness of the hour, the reading of the following paper was postponed until the next meeting :

Tricarbocyanines. [N. I. Fisher and F. M. Hamer.]

OBITUARY

Dr. JOHN THOMAS

Many chemists, and particularly those associated with the dyestuffs industry in this country, will learn with deep regret of the death on January 18 of Dr. John Thomas, joint managing director of the Dyestuffs Group of Imperial Chemical Industries, Ltd. By his death at the early age of 46 the industry has lost one of its most active and resourceful workers, and this Society must mourn the loss of one of its most distinguished members.

Dr. Thomas was educated at the Barmouth County School and from there he went to Aberystwyth University College. Subsequently he obtained an 1851 Research Scholarship and proceeded to Trinity College, Cambridge. In 1911 he joined the staff of the National Physical Laboratory at Teddington as a research chemist in the aeronautical department, and in the following year was appointed to the chemical staff of Nobel's Explosives Company at Ardeer, Scotland. During the next few years he was engaged on a number of important investigations with explosives and the value of these was recognized by the University of Wales in granting him the degree of Doctor of Science. It was in 1918 that he turned his attention to dyestuffs, being appointed to the post of chief chemist of the Solway Dyes Company, reconstituted two years later as Scottish Dyes, Ltd., of which he became a director, and three years' later managing director. This company was destined to take an important part in the post-war development of the dyestuffs industry in this country, particularly in connexion with the manufacture of fast dyes of the indanthrone type. For this essentially pioneer work Dr. Thomas was eminently fitted. His scientific genius, enabled him to make outstanding contributions to the scientific side and his part in the discovery of Caledon Jade Green, the fastest and best known colour of the indanthrone type, as well as in subsequent work on blue dyes of the same series, particularly Caledon Blue RC, places him among the foremost discoverers and investigators of the industry.

In 1926 Scottish Dyes, Ltd., was acquired by the British Dyestuffs Corporation, and Dr. Thomas ultimately became joint managing director of the Dyestuffs Group of Imperial Chemical Industries, Ltd., a position which he retained until his death. He was honoured by the dyestuffs industry for his work, and admired by his colleagues for his charming personality. In addition to his activities as a chemist he was a very fine golfer and last year captained the Royal St. David's Club, Harlech.

CORRESPONDENCE

VACUUM DESICCATORS

SIR,—Prof. Gibson's letter in your issue for December 23, 1932, prompts me to report a somewhat similar experience of several years ago. A 10-in. Frühling and Schultz type desiccator containing sulphuric acid as the drying agent, and petri dishes containing organic material for dehydration, had been exhausted with a water-jet pump a large number of times in the preparation of several lots of the material. It was finally left evacuated, with some of the dishes of material in it, for

a period of about two months; occasion then arose to use some of the material, and upon opening the stopcock the desiccator was found to be still under vacuum. However, the lid refused to slide off in spite of the lubricant on the ground surface, and in accordance with former practice, a short rubber tube was attached to the inlet and slight pressure applied by blowing gently on this tube. Instead of the lid loosening, the bottom sheared out inside of the cylindrical walls, as a disc about 8 in. in diameter and ⅜ in. thick. In spite of the unexpected result, no serious burns resulted, although the shoes and clothing of the operator were damaged.

Probably the long period of exhaustion had resulted in slight deformation of the bottom which was not immediately taken up on release of the vacuum, and the application of slight pressure sufficed to cause failure at the point of greatest strain.

I am, Sir, etc.,
F. A. McDermott

Stockdale,
Claymont, Del.
Jan. 5, 1933

STRUCTURE OF NAPHTHALENE

Sir,—I accept the criticism of H. W. Thompson (cf. Chem. & Ind., Jan. 20, p. 61), and agree that the symmetrical formula for naphthalene cannot be justified on steric grounds. Nevertheless, the results of substitution experiments are difficult to explain with any other structure.

I am, Sir, etc.,
F. Bell

Battersea Polytechnic,
S.W.11
Jan. 23, 1933

PERSONAL

Sir Harry McGowan, chairman of Imperial Chemical Industries, Ltd., intends to visit Palestine during February on his way home from India. Whilst the visit is primarily intended to enable Sir Harry McGowan to examine the progress made by I.C.I. (Levant), Ltd., it emphasizes the rapidly growing importance of Palestine as a market for British goods. Sir Harry is expected to be back in England in the first half of March.

Prof. Marston T. Bogert, past-president of this Society, is to give a series of lectures during the next few months in a number of American cities on the chemistry of perfumes and of vitamins.

We regret to learn of the death of Mr. C. H. Hardy, one of the directors of the Suffolk Chemical Co., Ltd., the Ipswich firm of alcohol and spirit manufacturers. Mr. Hardy had been a member of the Society for several years.

Mr. A. P. Garrett has been elected to a Casberd Scholarship in Chemistry in St. John's College, University of Oxford.

Mr. W. T. Rowe has been appointed director of chemistry and Government Analyst for South Australia on the retirement of Mr. W. A. Hargreaves.

Dr. R. E. Humphreys has retired from the position of vice-president in charge of manufacturing of the Standard Oil Co. of America. Dr. Humphreys was one of the earliest workers on the problems of oil refining. He joined the Standard Oil Co. as a chemist in 1900 and had been connected with the company ever since, being associated with Dr. W. P. Burton in his original work on oil cracking.

Dr. H. Eyring, research associate of the Frick Chemical Laboratory, Princeton University, has been awarded the prize of $1000 offered each year by the American Association for the Advancement of Science for the best paper submitted at the Association's winter meeting. The award was made for Dr. Eyring's paper on "Quantum Mechanics and Chemistry, with Reference to Reactions Involving Conjugate Double Bonds."

We regret to record the death of Dr. W. Heber Green, senior member of the staff of the chemistry department of the University of Melbourne. Dr. Green was appointed to the staff in 1899 and was awarded the degree of D.Sc. in 1905 for his researches on electrolytes.

Mr. J. F. Sutherland, chemical manufacturer of Lime Wharf Chemical Works, Falkirk, and director of the Scottish Tar Distillers, Ltd., left personal estate in Great Britain valued for probate at £405,358.

Chemical Society: Announcements

On January 19 it was announced that the following vacancies fall due to be filled at the Annual General Meeting on March 30: President: Vice-Presidents who have filled the office of President, two: Vice-Presidents who have not filled the office of President, two; Honorary Secretaries, two; Members of Council—Town, three; Country, three. Nominations must be received not later than February 14. The Council has made the following nominations: President, Prof. G. T. Morgan, O.B.E., F.R.S.: Honorary Secretaries, Prof. S. Sugden and Dr. J. M. Gulland. In the exercise of powers derived from the new Bye Laws, the Council has appointed Prof. S. Sugden as Honorary Secretary until the next Annual General Meeting.

The Ordinary Scientific Meeting on February 16 will be devoted to a discussion on "The Raman effect in relation to some chemical problems," to be opened by Dr. J. J. Fox.

The award of the Harrison Memorial Prize to Dr. H. J. Emeléus was announced.

Food Group

The meeting of the Food Group of the Society in March next is to take the form of a members' meeting, at which a number of short contributions will be given by members on any subject connected with foods or the food industry. Each contribution will be limited to fifteen minutes, with a short discussion to follow each contribution. The meeting will be held at Burlington House, on Wednesday, March 22, at 8 p.m.

Overseas Trade in 1932

Figures issued by the Board of Trade show that the total value of imports of merchandise into the United Kingdom during 1932 was £703,133,000, a decrease of £158,100,000 compared with 1931. The decline was due mainly to the change in the fiscal policy, but the value of imports was also affected by the downward trend of

prices. Imports of articles wholly or mainly manufactured were valued in 1932 at £104,000,000, or nearly 40% less than in 1931. Exports amounted in value to £365,138,000, or £25,500,000 less than in 1931, the decline being due wholly to price changes, the volume of exports being substantially the same, whilst the excess of imports over exports during the year was £287,081,000, some £119,000,000 less than in 1931.

Institute of Chemistry Examination Results

The following have passed the examination in general chemistry for the Associateship of the Institute of Chemistry: A. P. Backshell, G. C. Bailey, E. W. Basham, R. J. S. Broscomb, T. S. Eve, S. C. Mitchell, G. H. Moore, J. S. Ramskill, R. J. Shennan, J. H. F. Smith, C. T. Webster, E. White.

Asphalt Manufacture

In order to bring about the co-ordination and standardization of the materials, technical equipment, research, and executive practice connected with the manufacture and application of mastic asphalt, a central body has been formed to be known as the Natural Asphalte Mine-Owners' and Manufacturers' Council. The chairman is Mr. F. M. Bond of the Limmer & Trinidad Lake Asphalte Co., Ltd., and all the other principal asphalt companies in the United Kingdom are represented on the Council. Standard specifications have been drawn up governing the use of mastic asphalt in roofing, damp course and basement work, and flooring, and the Council will only grant permits to manufacture its standard materials to factories which have been registered and approved, whilst a standard code of practice in applying asphalt has been drawn up which all the represented companies will undertake to observe. The address of the Council is Terminal House, Westminster, London, S.W.1.

Manchester College of Technology

Textile Machinery Makers, Ltd., the new company in which several of the leading textile machinery makers have recently been merged, has presented the Manchester College of Technology with an installation of some of the latest types of cotton machinery. In thanking the company for the gift Prof. Merton stated it to be the most valuable which had been made at one time since the College was first equipped with a textile department.

Alcohol-Petrol Admixtures in Central Europe

One consequence of the present tendency to restrict imports in Central European countries has been to stimulate the search for new motor fuels. The decline in the consumption and export of sugar and alcoholic beverages has further encouraged the attempts to produce a satisfactory alcohol–petrol mixture suitable for motor engines.

So far, users of the mixed fuels have reported that these are not so efficient as petrol alone. In fine weather and in southern countries or in the height of summer, the mixtures are more satisfactory but in rainy or damp weather the mixtures are liable to absorb moisture from the atmosphere and thus deteriorate. Another difficulty is that it has been left to the dealers to mix the alcohol and motor spirit. Consequently it is obvious that the proportions of the ingredients can vary considerably and petrol of too high a specific gravity or alcohol of less than the required 98% to 99% purity may have been used. Another disadvantage caused by the presence of alcohol is that it discolours or exerts a solvent action on certain varnishes should it be accidentally spilled during filling operations or in any other way.

More success is claimed for a mixture of 40% petrol (sp. gr. 0·72 to 0·73), 20% alcohol, and 40% benzol. This admixture is claimed, according to a report from Czechoslovakia, to be quite satisfactory and to be free from the drawbacks associated with the simple alcohol-petrol mixtures. Unfortunately, the price of this product is about 10% higher than that of ordinary motor spirit.

European Graphite Companies Combine

According to the *Financial Times* the largest graphite company in Europe has been brought into existence by the fusion of several German concerns. The central company is the Graphitwerk Kropfmühl, which is absorbing two companies in Bavaria, and the larger concern known as the Graphiterke G.m.b.H. of Dohna, Dresden, owned by the Berlin chemical company Rutgerswerke. It will thus become the only German graphite company.

R.E. Gas & Anti-Gas Services Reunion Dinner

A reunion dinner for members of the Gas and Anti-Gas Services of the Royal Engineers will be held on Saturday, February 4, at the headquarters of the Artists' Rifles, Duke's Road, Euston Road, W.C.1, at 7 for 7.30 p.m. (lounge dress). Major-Gen. C. H. Foulkes, C.B., C.M.G., D.S.O., will preside. Tickets, price 6s. each, can be obtained from Mr. H. W. Lucas, 47, Kynaston Crescent, Thornton Heath, Surrey.

Montreal British Coal Imports

According to the U.S. Commerce Department the amount of British coal shipped to Montreal last year constituted a new high record. Shipments totalled 1,335,000 t. as compared with 706,000 t. in the previous year, anthracite showing an increase from 669,000 t. to 1,119,000 t.

Institute of Metals

The president of the Société des Ingénieurs Civils de France, M. Albert Portevin, has accepted the invitation of the Institute of Metals Council to give the Annual May Lecture before the Institution. The lecture will be given at 8 p.m. on May 10 at the Institution of Mechanical Engineers, Storey's Gate, Westminster, and M. Portevin will take as his subject "Quenching and Tempering Phenomena in Alloys." Cards of admission are obtainable from the secretary of the Institute of Metals, 36, Victoria Street, S.W.1.

The Institute celebrates its twenty-fifth anniversary this year, and its general meeting will be held in London on March 8 and 9, when a number of papers will be presented for discussion. The annual dinner will be held on the evening of March 8 under the chairmanship of Sir Henry Fowler, K.B.E., president of the Institute.

Combustion in the Boiler Furnace

As one of its activities the West Riding Regional Smoke Abatement Committee has established a scheme for the examination and certification of stokers and boiler attendants, for whom classes have been arranged

in the technical institutions of the area. It has been found that there is little literature available in a form and at a price suitable for such students, and an endeavour to remedy this defect has been made in the publication of a little book of twenty-four pages, entitled "Combustion in the Boiler Furnace," by Mr. H. J. Hodsman, M.B.E., M.Sc., of the Department of Coal Gas and Fuel Industries in the University of Leeds. Mr. Hodsman is well-known to all members as the honorary secretary of the Yorkshire Section of the Society. The book is a very creditable endeavour to explain the combustion of coal and the underlying chemical principles in simple terms that will be readily understood. It can be obtained from Messrs. Jowett & Sowry, Ltd., Albion Street, Leeds, price 1s. post free.

American Chemical Society

The Council of the American Chemical Society has elected as its president for 1934 Dr. Charles L. Reese, who retired in 1931 from the position of chemical director of E. I. du Pont de Nemours & Co., after having been associated with the firm for nearly thirty years. Dr. Reese has occupied a prominent position in the American chemical industry for many years, and has served as president of the American Institute of Chemical Engineers and of the Manufacturing Chemists' Association, and as an officer of several other scientific bodies.

Timber Research

The Report of the Forests Products Research Board for the year 1931, just published (H.M. Stationery Office, 3s. 6d.), indicates that considerable advances have been made in the facilities for investigating the effects of the dry rot fungus and the death watch beetle. A new experimental building has been erected at Princes Risborough, and the rooms in this have been constructed to simulate the variety of conditions which obtain in practice, and the dry rot is being studied in these various conditions. The resistance to dry rot of various makes of wall board is also being studied, the majority of the pulp boards proving susceptible to fungal decay in the presence of sufficient moisture. Investigations with the death watch beetle have so far dealt primarily with the biology of the insect, but it is interesting to note that some difficulty has been experienced in getting an adequate supply of insects for this work. Correspondence has shown that the damage caused by this insect is often confused with that due to the less important furniture beetle or even the dry rot fungus. The report refers to the difficulties encountered on carrying out satisfactory tests on the efficiency of various insecticides aimed at destroying the death watch beetle owing to the impossibility of selecting samples of wood known to contain living insects, whilst information is also needed regarding the penetration of liquids and gases into timber. Considerable progress is recorded in the work on Empire timbers, and it appears that a vigorous policy of development and exploitation of the forest reserves of the Empire would eventually render the whole Empire almost independent of foreign supplies. There is room also for considerably greater consumption of Canadian softwoods within the Empire. The report describes improvements in the design of drying kilns, new apparatus for determining humidity in kilns, and a method of measuring interstitial space in timber by means of the photo-electric cell.

German Potash Production

The production of potash salts in Germany during 1931 was 8,050,000 metric tons, equivalent to 1,080,000 t. of pure potash. This figure is 32% less than the output in the previous year. Kainit and crude salts accounted for 42% of the output whilst the production of Carnallite showed a further decrease to 13%, as against 35% of the total made up by this salt in 1924.

Notes from India

Sugar manufacture.—A process of manufacturing white sugar from sugar cane in Southern India has been developed at the Coimbatore Agricultural College. The process follows the usual practice of crushing and boiling the juice in open pans, a special multiple pan furnace having been designed for the purpose by Mr. Srivathava, Sugar Technologist to the Imperial Council of Agricultural Research, the fuel used being the trash and bagasse obtained in crushing. A material obtained from the local "sajji," or alkaline earth, is used as a clarifying agent, and when the juice has reached a certain consistency, just below that used in manufacturing the ordinary crude sugar or "jaggery," it is centrifuged. The operating costs are stated to be very economical and the process should be of considerable help to agriculturists.

Soil research.—The Imperial Council of Agricultural Research in India has recently made a grant of Rs. 6,50,000 for the carrying out of research on soils in Northern India. The research will deal mainly with saline and alkaline soils.

Indian lac industry.—The Government of India has sanctioned the proposal of the Indian Lac Cess Committee to depute three Indian students to proceed to the United Kingdom for work designed to improve the quality of lac so as to meet the needs of customers in England and the Continent, to discover new uses for lac, and to strengthen the position of Indian lac in competition with synthetic substitutes. The Indian scientists will work in the laboratories of the Consumers' Research Organization. One will work in the electrical industry, another in the oil, paint, and varnish industry, and the third in the plastics industry.

Technological laboratory in Nagpur University.—In order to promote industrial development in the Central Provinces the University of Nagpur has decided to establish a Technological Laboratory for the teaching of applied science, especially industrial chemistry, geology, mining, metallurgy, and engineering technology. The subjects are to be taught mainly with reference to industries capable of being started or developed in the Province, and with a view to giving practical training small factories will be started in selected industries.

Indian Institute of Science.—Sir C. V. Raman, director of the Indian Institute of Science, Bangalore, has appealed for half a million rupees to establish a Physical Laboratory in the Institute. It is intended that this shall be a connecting link between the Departments of Chemistry and Electro-Technology: new lines of research of practical importance will then be undertaken in India for the first time.

REVIEWS

INTRODUCTION TO THE SCIENTIFIC STUDY OF THE SOIL. By N. M. Comber, D.Sc. 2nd ed. Pp. 208. London: E. Arnold & Co., 1932. 7s. 6d.

Although agriculture is one of the oldest of the arts, the scientific study of the soil did not really commence until 1840, when Liebig demonstrated the true function of nitrogen, potash, and phosphorus. Since then however, our knowledge of agriculture in general and of the soil in particular has grown steadily, but the progress has been exceptionally rapid during the past fifteen years or so, so rapid in fact, that as Prof. Comber remarks, it may fairly be claimed that the study of soil formation processes and soil types has given to soil science a fundamental characteristic which has been properly recognized by the adoption of the word *pedology* to describe the science of the soil. For this remarkable progress no small credit is due to Russian pedologists, with some of whom Prof. Comber had the privilege of comparing notes during the summer of 1930.

Along with these rapid advances there has been of course, a corresponding increase in the number of publications devoted to soil, so that the student is apt to be bewildered rather than assisted by this mass of literature. It is for this very reason that Prof. Comber has prepared this book, a book which will prove a boon to those students, be they agricultural diploma students whose studies are mainly vocational, or agricultural degree students whose work is essentially academic, who wish to obtain in a concise and readable form a knowledge of the fundamental principles of soil science. At the same time, realizing that the more advanced student must be familiar with the literature in order to keep abreast of the latest developments of the subject, Prof. Comber has been at considerable pains to prepare a chapter on "The Literature of Soil Science and its Use" which includes a selected bibliography of some 120 papers. His ripe experience, both as a teacher and as an experimentalist, well fit him for the task he has undertaken, and in preparing a second edition in which certain sections have been extended and the whole of the matter brought up to date, he has earned the gratitude of teachers and students alike.

Although designed primarily for students, the book will be of considerable service to all those who are directly concerned with the soil, be they agriculturists, botanists, horticulturists, or ecologists, whilst it can be strongly recommended to chemists as a fascinating and lucid account of this most important branch of applied science.

SIGNIFICANCE OF SPORES IN THE CORRELATION OF COAL SEAMS. PART II.—THE BARNSLEY SEAM, SOUTH YORKSHIRE AREA. PART III. THE SILKSTONE SEAM, SOUTH YORKSHIRE AREA. By L. Slater, Ph.D., and G. E. Eddy, M.Sc. Department of Scientific and Industrial Research. Fuel Research. Physical and Chemical Survey of the National Coal Resources No. 23. Pp. vi+25. London: H.M. Stationery Office, 1932. 2s.

The correlation of coal seams is dependent largely upon the correct identification of the associated strata. The distinct characteristics of fossils are an infallible means of determining geological horizons, but the difficulty of locating the beds in which they occur and interruption of the sequence of the strata through faulting and folding often render useless this means of identification. Correlation based on chemical data relating to individual coal seams is not as yet possible. The classification and concentration of plant remains, of a resistant nature and a clearly recognizable structure, occurring in coals, offer however an attractive and possible means to this end.

In Part I of this report (Survey Paper No. 17) a microscopical examination of sections of the Parkgate seam showed that the varying concentrations of several types of spore exines were probably characteristic. The results of a similar examination of sections of the Barnsley and Silkstone seams in the South Yorkshire area are now reported textually and diagrammatically, two large plates showing photomicrographs of vertical sections of megaspores classified according to structure and growth into seven groups being included by way of illustration. As far as the Barnsley Seam is concerned it is concluded that only the spore type and distribution in certain portions of the seam are necessary for the identification of this seam over a wide area in S. Yorkshire. Spore distribution in the Silkstone Seam, which appears to change as the seam is traced towards the south, shows few points of similarity with that of either the Parkgate or Barnsley seams. The method involves a high and laborious technique and the present results are not sufficiently conclusive to render probable its general adoption. Extending the study to other coal seams may prove however that spore distribution and type are suitable as zonal indices and, complementary in this respect, to fossils. A. McCULLOCH

RAFFAELE PIRIA, LAVORI SCIENTIFICI E SCRITTI VARI. Raccolti da D. Marotta. Associazione Italiana di Chimica, Roma. Pp. viii + 638. Roma: Tipografia Editrice Italia, 1932.

The works of Piria have never before been collected in a single volume, and Prof. Marotta is to be commended for what must have been a laborious search for papers and scattered publications. Piria represents the link between Avogadro and Cannizzaro in a chain of renowned Italian chemists; he may be also regarded as the founder of an Italian school of chemistry in a period in which it was deemed almost inconceivable that this science could be developed elsewhere than in Germany or in France. He is honoured in his own country as a pioneer, a teacher, and an organiser, as well as a research worker of outstanding ability.

Born in 1814 at Scilla (Calabria) Piria was awarded in 1834 the degree of Doctor of Medicine in the Medical College of Naples. In 1836, he travelled to Paris where he became a pupil and a co-worker of Dumas. On returning to Italy in 1838 he opened a private school of chemistry in Naples, but in 1842 accepted the professorship of chemistry in the University of Pisa, where he accomplished the greatest part of his researches. His work on salicin was completed and followed by the investigation on asparagin, aspartic acid and populin, and more than 30 papers published by Piria cover a wide range of subjects, most of them dealing with

pure organic chemistry. Piria was a skilful manipulator, and his black-flux method for determining halogens remains to-day a standard method in analytical organic chemistry. In 1848 he took active part in the First War for Italian independence, afterwards retiring to private work, and jointly with Matteucci he edited the scientific periodical "Il Nuovo Cimento."

In 1855 the Piedmontese Government offered him the chair of chemistry at the University of Turin, and he retained this post until his death in 1865. Italy's political crisis during the last decade of his life distracted Piria from research work. In 1860 he was appointed Minister of Education in the Provisional Government at Naples. During this period he re-organized the Turin laboratories and published his book "Lezioni elementari di Chimica Organica," a companion to "Trattato di Chimica Elementare Inorganica," which appeared in 1841, the first book on chemistry written by an Italian.

VON DEN KOHLEN UND DEN MINERALÖLEN: EIN JAHRBUCH FÜR CHEMIE UND TECHNIK DER BRENNSTOFFE UND MINERALÖLE. Edited by the Fuel and Mineral Oil Chemistry Section, Vereins Deutscher Chemiker. Vol. IV, 1931. Pp. 234. Berlin: Verlag Chemie, 1932. Paper, 16 m. Bound, 18 m.

The fuel and petroleum group of the German Chemical Society performs a very valuable service by issuing this year-book. The book contains the essential matter of thirteen lectures, delivered in Vienna. Dr. G. Baum, the secretary of the group, explains in the introduction the difficulty of dealing with the large amount of material available and at the same time restricting the volume to a convenient size. The onerous duty however appears to have been carried out successfully, and a very useful volume is the result.

Fischer and Pichler deal with the influence of pressure on water-gas reactions, while Farkas discusses the mechanism of the combustion of gaseous fuels. Rosin gives excellent information on the buruing of powdered fuels, with particular reference to the behaviour of particles of various sizes and shapes. The fourth lecture by Terres contains the results of many years' research on the process of combustion in motors, and the six-stroke principle. There is a mass of data and while this review is not the place to support or criticize the six-stroke cycle, there is much of interest in Dr. Terres' work and method of presenting results. A new method for the rapid determination of unsaturated compounds in mineral oils is described by Galle, while Schaarschmidt deals with the separation of branched-chain aliphatic hydrocarbons in mixtures by means of antimony pentachloride.

Müller and Jandl describe an improvement in the method of determining the reactivity of coke and Melzer gives particulars of the technique for determining the ignition point of coke. The extraction of benzol from coke oven and coal gas by the Linde process is treated by Schuftan, followed by a report on sulphur in motor fuels by Kiemstedt.

Grote gives particulars of the production of high-grade anti-knock fuels by the Edeleanu process, while Schmidt discusses the relation between structure and knocking properties of fuels. Finally, Conrad gives details of a new method for determining the boiling range of liquid fuels. The book contains 38 tables and 91 illustrations and can be recommended to all interested in fuel research. A. M.

COMPANY NEWS

BOOTS PURE DRUG CO.

A meeting of the company was summoned on January 20 for the purpose of passing a resolution to sub-divide the £1 ordinary shares into shares of 5s. each, but a few days prior to the meeting shareholders were informed that this resolution would not be submitted, a resolution being moved at the meeting for adjournment *sine die*. At the meeting Lord Trent stated that the company had nothing to do with the recent negotiations (cf. CHEM. AND IND., Jan. 6) for the sale of the controlling interest in the company. The only part which had been taken by the Board whenever they had been approached had been to stress the absolute necessity for ensuring as far as possible continuity of the company's policy of management, but the Board could not prevent shareholders from disposing of their interests in the company.

CANADA CEMENT CO.

The report of the Canada Cement Co., which makes and sells Portland cement, shows trading profits and income from investments during the year ended November 30, 1932, of $2,086,073, with $555,649 provided for depreciation. This compares with earnings of $3,111,320 last year after the provision of $2,071,102 for depreciation. During the year consumption of cement in Canada fell off to the extent of no less than 52%, almost wholly as a result of the decline in building.

LAUTARO NITRATE CO.

The report of the company for the year ended June 30 last shows an operating deficit of $5,871,900, equivalent to about £1,174,381 at par, compared with a loss of £656,510 for the previous year. In the last balance-sheet, based on book values adopted before the company became a subsidiary of Cosach, a deficit of £336,155 was shown, but the balance-sheet now shows a capital surplus of $30,977,867, or £6,195,600, after deducting the year's loss. During the year 623,280 metric tons of nitrate were produced, as against 367,606 in the previous year. The directors point out that under the merger scheme the company has had the benefit of participating in world sales to the extent of more than 34·5%, as against 25·14% achieved in the previous year under the regime of the Nitrate Producers' Association.

BLUNDELL, SPENCE & CO., LTD.

The profit of this company of paint and varnish manufacturers for the year ended October 31 last amounted to £26,627. It is proposed to resume dividend payments on the ordinary shares with 3% payable on February 14, £4876 being placed to general reserve and the forward balance being increased from £7648 to £10,071. During the year a factory was acquired in Chile and a subsidiary company was formed in Australia, which has now commenced to operate.

MARKET REPORT

This Market Report is compiled from special information received from the manufacturers concerned.

Unless otherwise stated, the prices quoted below cover fair quantities net and naked at sellers' works.

The following alterations in prices are reported since the publication of the last Market Report (cf. CHEM. & IND., Jan. 6, 1933, p. 17).

GENERAL HEAVY CHEMICALS

Acid, Acetic, 40% *tech.*—£20 5s. per ton d/d address U.K. in casks.

Sod. Phosphate.—£13 per ton, f.o.r. London, casks free. Sod. Silicate 140° Tw.—Spot, £8 5s. per ton d/d station returnable drums. Sod. Sulphate (Glauber's Salt).—Spot, £4 2s. 6d. per ton d/d. Sod. Sulphide solid, 60/62%.—Spot, £10 15s. per ton, d/d in drums. Crystals, 30/32%.—Spot, £8 per ton, d/d in casks. Sod. Sulphite, Pea Cryst.—Spot, £13 10s. per ton, d/d station in kegs; Commercial.—Spot, £9 10s. per ton, d/d station in bags.

PHARMACEUTICAL AND PHOTOGRAPHIC MATERIALS

Acid, Acetic, Pure 80%.—£39 5s. per ton d/d address U.K. in casks.

Phenacetin.—4s. 6d.—4s. 9d. per lb.

Potass. Bitartrate.—99/100% (Cream of Tartar), 85s. per cwt., less 2½%.

INTERMEDIATES

Items marked thus * d/d buyers' works.

*β-Naphthol.—Spot, £78 15s. per ton, in paper bags; £79 15s. per ton in casks, in 1-ton lots.

*Nitrobenzene.—Spot, 4½d. per lb., 5-cwt. lots, drums *extra*.

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence), 35, Old Queen Street, London, S.W.1, has received the following inquiries for British goods. British firms may obtain further information by applying to the Department and stating the specific number *British India:* Essential oils, aromatic chemicals, soap (79). *Canada:* Oleic acid, stearic acid, aniline oil, shellac, calcium chloride, tin crystals, egg albumen, chrome alum, argols, bicarbonate of soda, bluestone, silicate of soda, benzoate of soda, formaldehyde, tri-sodium phosphate, disodium phosphate (90). *Egypt:* Iron, steel, and metal manufactures (copper, tin, zinc), vegetable oils (including linseed oil) (111); Varnishes, cellulose lacquers, dry colours (red lead, ultramarine blue, zinc white, lithopone, etc.), linseed oil (113): Sensitive paper and chemicals (B.X. 7489). *France:* Chemical and pharmaceutical products, including sulphide of iron, phosphate, fluosilicate, borate and pharmaceutical anhydrous sulphate of soda, and crystallized naphthalene (105). *Mexico:* Tinplate (119). *Turkey:* Caustic soda, soda silicate, caustic potash, chloride of potash, sulphate of potash (115).

Import Duties Advisory Committee

The Import Duties Advisory Committee gives notice of application for drawback under Section 9 of the Finance Act, 1932, in the case of the following: Paints and other commodities, in respect of the imported linseed and linseed oil used in their manufacture, and in the case of linseed oil in respect of imported linseed; phenacetin, in respect of the para-phenetidine used in its manufacture; stainless-steel sheets of austenitic (18/8) quality from 3 to 26 s.w.g. in thickness, in respect of the billets or slabs of stainless steel used in their *manufacture: chewing gum, in respect of the gutta*-percha compound (chewing gum base) used in its manufacture; stencil paper, in respect of the hand-made Tengujo paper known as dental tissue, used in its manufacture.

Any representations in regard to these applications should be addressed to the Secretary, Import Duties Advisory Committee, Caxton House, Tothill Street, S.W.1, not later than February 6, 1933.

Sulzer Technical Review

In the latest number of the *Sulzer Technical Review* (No. 4, 1932) an article particularly worthy of notice is that dealing with the high-pressure steam generator developed by Sulzer Bros. during the last few years. The article reviews the features of specially designed boilers such as the Atmos, Schmidt's, the Löffler, and the Benson, and then outlines the advantages of the Sulzer single-tube steam generator. Other interesting articles in this number deal with heating, ventilating, and air-cooling plants, and the use of Diesel-electric shunting locomotives.

Henry Wiggin & Co., Ltd.

A very interesting booklet has recently been issued dealing with the works and products of Henry Wiggin & Co., Ltd., in which is incorporated the former business of Monel-Weir. Ltd. Particulars are given of the various operations in the production of nickel and nickel alloys, together with a number of particularly attractive drawings illustrating such operations as forging, casting, wire-drawing, and pickling. Various alloys are described and their properties and uses are briefly dealt with in a general way.

PUBLICATIONS RECEIVED

GAS JOURNAL CALENDAR AND DIRECTORY, 1933. Pp. XL + 252. London: W. King, Ltd., 1933.

GMELINS HANDBUCH DER ANORGANISCHEN CHEMIE. 8th *new revised edition. Edited by the German Chemical* Society. System Number 30. Barium. Pp. xvi + 390. Berlin: Verlag Chemie, 1932. 64 m.; subscription price, 56 m.

ECONOMIC CONDITIONS IN ITALY, SEPTEMBER, 1932. Prepared *by the Commercial Secretariat to His Majesty's* Embassy at Rome. No. 532. Department of Overseas Trade. Pp. 84. London: H.M. Stationery Office, 1932. 2s. 6d.

UNTERSUCHUNGSMETHODEN FÜR ARZNEISPEZIALITÄTEN. *ZUSAMMENGESTELLT VON DER* SPEZIALITÄTEN-KOMMISSION DES INTERNATIONALEN APOTHEKERBUNDES. Pp. 87. Leyde: Fédération Internationale Pharmaceutique; Amsterdam: D. B. Centen's Wetenschappelijken Boekhandel, 1932. 3 fls: 5 rm.

STUDI E RICERCHE SUI COMBUSTIBILI. By Prof. M. G. Levi. Vol. III (1930—1931). R. Politecnico di Milano. Pp. xii + 390. Roma: Tipografia Editrice Italia, 1932.